OE FORM 6000, 2/69

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF EDUCATION

ERIC REPORT RESUME

ERIC ACC. NO. ED 035 788			
CH ACC. NO. AA 000 491	P.A. 08	PUBL. DATE 31 Dec 69	ISSUE RIEJUN70

IS DOCUMENT COPYRIGHTED? YES ☐ NO ☒
ERIC REPRODUCTION RELEASE? YES ☐ NO ☒
LEVEL OF AVAILABILITY I ☒ II ☐ III ☐

AUTHOR
Straubel, James H.

TITLE
The Evaluation of Three U.S. Air Force Instructional Systems Within Civilian Education. Final Report.

SOURCE CODE FGK00251	INSTITUTION (SOURCE) Aerospace Education Foundation, Washington, D.C.
SP. AG. CODE RMQ66004	SPONSORING AGENCY Office of Education (DHEW), Washington, D.C. Bureau of Research.

EDRS PRICE 0.50;5.85	CONTRACT NO.	GRANT NO. OEG-3-8-080301-0035(085)
REPORT NO.		BUREAU NO. BR-8-0301

AVAILABILITY

JOURNAL CITATION

DESCRIPTIVE NOTE
115p.

DESCRIPTORS
* Vocational Education; * Technical Education; * Military Schools; * Instructional Programs; * Public School Systems; Program Evaluation; Instructional Materials; Electronics; Aviation Mechanics; Nurse's Aides; High Schools; Technical Institutes; College Instruction;

IDENTIFIERS

ABSTRACT

This research was designed to study the effectiveness of transferring vocational-technical military training into the civilian education system. The military training, which was tested in six Utah schools ranging from high school to 4-year college, included electronics principles (90 hours), aircraft pneudraulics (60 hours), and nurse's aide (20 hours). The courses were offered in two forms to students chosen randomly; gain scores generally favored the experimental or military methods. Experimental electronics and nurse's aide courses were completed in substantially less time than the control courses with little or no modification of military instructional materials. Utah educators reacted favorably to the integration of military instructional techniques and materials into regular curriculum and additional courses were requested. Evidence indicates that results generally are applicable to other states. (CH)

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FINAL REPORT

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December 31, 1969

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
Office of Education
Bureau of Research

ED 035 788

VT

PROCESSING CONTROL RECORD

for

MUST and MUST - EXPEDITE DOCUMENTS

ERIC FACILITY

Document Identification Number BR 8-0301

Date Received from Central ERIC 3/2/70

Date Shipped to Clearinghouse 3/3/70

ERIC CLEARINGHOUSE

Date Received 3-10-70

Clearinghouse Accession Number

Date Shipped 20/3/70

ERIC FACILITY

Date Received

ED Accession Number

Date Shipped to EDRS

FINAL REPORT

Project No. 8-0301

Grant No. OEG-3-8-080301-0035 (085)

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THE EVALUATION OF THREE U. S. AIR FORCE INSTRUCTIONAL SYSTEMS WITHIN CIVILIAN EDUCATION

by

James H. Straubel
Aerospace Education Foundation
Washington, D. C.

December 31, 1969

The research reported herein was performed pursuant to a contract with the Office of Education, U. S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

PREFACE

The work reported here represents the first attempt to systematically explore the feasibility of applying military training experience to civilian education.

Heretofore the transfer of concepts, techniques and course materials from military to civilian classroom had been accomplished in bits and pieces without a supporting effort to structure the procedures involved and assess the results obtained.

Such a supporting effort, as covered in this report, was the first of its kind ever funded as a major research project.

The impact of this effort in the state of Utah, site of the experiment, already has been felt in directly related classroom projects beyond the parameters of the study itself. This immediate follow-on activity in Utah, not contemplated in the study plan, provides tangible evidence that there can be a close relationship between research findings and operational productivity -- when the will is there for constructive change.

ACKNOWLEDGEMENTS

The project covered in this report originated in the civilian sector of society, specifically among a group of civic-minded citizens in the state of Utah. It involved, in Utah, not only many members of the educational community, but industrial and union representatives as well; and it also involved many members of the United States Air Force -- from the Chief of Staff in Washington to officers and airmen throughout the Air Training Command -- all of whom deserve special recognition for the enthusiastic cooperation which made the project possible. Many such people, to whom credit is due, must go nameless in these acknowledgements. Beyond that, the Aerospace Education Foundation expresses its deep appreciation to the following individuals for their participation in or assistance with the project:

Utah Educators

Dr. Ted H. Bell, Superintendent of Public Instruction; Mr. Walter E. Ulrich, Jr., Administrator, Vocational and Technical Education.

Project supervisors and teachers: Mrs. Sandra Noall, Mrs. Patty Hansen, Mrs. Jean Larson, Mrs. Margaret Nelson, Mr. Gene Forsberg, Mr. Samuel Merrill, Dr. Neill Slack, Mr. Hurschell Urie, Mr. Ronald Harris, Mr. James Lewis, Mr. Robert Salmond, Mr. Ira Stone, Jr., Mr. Marvin Persinger, Mr. Rorden Payton, Mr. Joseph Baker, Mr. Dallas Christinsen, Mr. William Walker, Mr. Don James, Mr. Kenneth Hacking, Mr. Gordon Moses, Mr. Roger Kind, Mr. Robert Kresge.

U. S. Air Force

General John D. Ryan, Chief of Staff; General John P. McConnell, Former Chief of Staff; General Horace M. Wade; Lt Gen Sam Maddux; Lt Gen J. W. Carpenter; Lt Gen Albert P. Clark; Maj Gen Leo F. Dusard; Maj Gen Lester F. Miller; Brig Gen J. M. McNabb; Col John Mitchell; Col F. O. Hinckley; Col H. A. Jones; Col James Havey; Col Geoffrey P. Wiedeman; Col Henry C. Reed; Col Nelson O. Pohl; Lt Col William Strother; Lt Col Robert Gerry; Lt Col William Broome; Lt Col Virginia L. Waddill; Maj John Phipps; Mr. William Perry; Mr. Hilton Goldman; Mr. Earl Wallace; Mr. W. S. Neale; Mr. Charles Schmedeke; Mr. E. B. Bonevitz; Mr. John Manley.

Air Force Association

Mr. Nolan Manfull, Regional Vice President; Mr. Jack Price, Past President, Air Force Association (Utah); Mr. David Whitesides, Past President, Air Force Association (Utah).

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I. SUMMARY

The Problem: To determine whether military experience in vocational-technical education can be transferred, with effectiveness, into the civilian education system.

Scope of Study: To examine three U. S. Air Force instructional systems, through segments of these systems selected by Utah educators, in terms of their usefulness in six Utah schools ranging from a high school to a four year college. Air Force course segments utilized: Electronics principles (90 hours - Jordan High School, Salt Lake City; Utah Technical College, Salt Lake City; Utah Technical College, Provo; Dixie College, St. George; Weber State College, Ogden); Aircraft Pneudraulics (pressure mechanics) (60 hours - Utah State University, Logan); Nurse's Aide (20 hours - Utah Technical College, Salt Lake City).

Objectives: To determine empirically the civilian effectiveness of three U. S. Air Force instructional units by comparing them with their counterparts in selected educational institutions in Utah; to assess the extent to which results obtained might be applicable to civilian education systems nationally.

Methods: Air Force course segments generally were offered in two forms: one of them exactly as offered by the Air Force, the other with modifications (as determined by Utah educators) which more properly can be considered augmentations (i.e., an additional algebra unit in the electronics course). With semi-random student selection, the experience of students using the two Air Force course segments (Experimental Groups) was compared with that of students using the conventional Utah course segment (Control Group). Only civilian teachers from the Utah educational system were involved.

Results: Use of Air Force techniques and materials resulted in student performance as good or better, in each instance, than student performance resulting from the use of conventional techniques and materials; gain scores generally favored the Air Force techniques and materials; in two instances (Electronics and Nurse's Aide) as good or better student performance was obtained in substantially less class time than with the conventional course; all these results were achieved with little or no modification of Air Force materials and, in one instance (aircraft pneudraulics) with the use of only one-third the equipment prescribed for the Air Force course segment; results were achieved with minimum modification costs.

Highlights: The definite conclusion that it is feasible to use Air Force techniques and materials in Utah's civilian classrooms is supported by the positive reaction of Utah educators to the experiment. In each subject area studied, Air Force techniques and materials have been integrated into the regular curriculum in each of the test schools, and in other schools as well. Further, state-wide application of electronics instruction based on specified performance objectives, as exemplified by Air Force courses, now is in progress. All evidence points to the conclusion that other states could share this Utah experience.

Recommendations: That military educational concepts, techniques, course materials and equipment requirements, on a broad scale be inventoried and assessed in terms of their applicability and dissemination to civilian education, with full cognizance of this experience in Utah; that further study be made of Air Force techniques and course materials, based on this Utah project, to determine how more effective use of them might be made by civilian institutions; that a specific study be made of the Air Force use of performance objectives, and of the ability of civilian educators to relate such objectives to their own requirements, with guidelines for the effective application of such objectives to civilian vocational-technical education.

THE EVALUATION OF
THREE U. S. AIR FORCE INSTRUCTIONAL SYSTEMS
WITHIN CIVILIAN EDUCATION

by

James H. Straubel
Aerospace Education Foundation

II. INTRODUCTION

It is a paradox that the accelerating rate of technological change carries with it not only the promise of a richer, fuller life for all, but also a sense of frustration and bitterness for many in our nation. Numbers of young people find themselves unemployed and unemployable, simply because they do not know how to do much, if anything, that is useful in the realm of the new technology. Numbers of older people find their skills outdated, obsolescent in a changing world. Both young and old know that strong muscles and a willingness to work are not enough. The skills that are sought after are those of the brain, the intellect.

Thus the importance of what is generally known as vocational-technical education has rapidly increased. It offers at least part of the answer to the problems posed by "skill imbalance." Many vocational-technical institutions are working hard to expand their capability of providing the skills so badly needed by so many. And yet, they seem not to be moving fast enough. Sadly, and to the detriment of a virile society, many young people are not being equipped with the skills through which they could contribute to fulfillment of themselves and of their community.

Side by side with the civilian public school system of the nation there exists another great segment of American education, the military training establishment. A major part of military training is devoted to the very aspect of education in which the public school system finds it hardest to keep pace -- vocational-technical education. The Air Training Command of the U. S. Air Force, in particular, is a vast reservoir of instructional concepts, techniques and materials of proven effectiveness. The obvious question is: "Would they also be effective in civilian vocational-technical institutions?"

It is to this question that the current study and a preceding pilot study have been directed.

Historically, the current study had its beginning in 1966 when, at a seminar of the Aerospace Education Foundation, national education leaders expressed the belief that the Foundation could serve as a catalyst in applying educational technology, as incorporated in Air Force courses, to the civilian classroom. The Chief of Staff, United States Air Force, enthusiastically agreed that the Foundation should provide liaison between the civilian community and the Air Force in exploring this suggestion.

In the meantime, the state of Utah and Hill Air Force Base, the largest employer in that state, had studied manpower needs. Using a ten-year projection, they determined that in certain priority areas neither the quality nor numbers of personnel needed by the Air Force and by the state's industry could be met by the Utah educational system. Three of the priority areas identified were electronics, medical technician, and aircraft maintenance. In March, 1967, at a meeting of the Foundation's Educational Technology Advisory Committee, leaders of the Utah state organization of the Air Force Association reported that Utah educators were interested in the possibility of using Air Force materials. In further discussions, prompted by the Aerospace Education Foundation, the Utah public education system agreed to serve as a "laboratory" to explore the feasibility of using such courses in civilian education.

To this end, representatives from Utah's Division of Vocational and Technical Education reviewed basic information on 19 Air Force courses and selected three (electronics principles, aircraft mechanics, and medical service specialist), as having priority within Utah as well as nationally. Each of these three occupational specialties represents a growth area in terms of national employment trends, according to the latest projections available from the Bureau of Labor Statistics, U. S. Department of Labor.

Under a grant from the U. S. Office of Education to the Aerospace Education Foundation (Project No. 8-8018, Grant No. OEG-0-8-088018-0201-085), a three-month pilot study explored the possibility of using segments from each of the three Air Force courses within Utah's educational system. This study was conducted by personnel from the Aerospace Education Foundation, the office of the Utah State Superintendent of Public Instruction, the Utah educational system, and the Columbus laboratories of Battelle Memorial Institute, assisted by personnel of the United States Air Force, serving on a voluntary basis.

The pilot study concluded that it would indeed be feasible to adapt, implement and evaluate, within the Utah educational system, selected segments of the Air Force courses reviewed. It was further hypothesized that if the courses were helpful in meeting Utah's educational needs, they might well be helpful in many other states. 1/

In making these judgments, the study group projected certain questions, relative to the Utah school system, such as the following:

* Does the proficiency yield of the Air Force courses meet the requirements of civilian schools?

* Do the objectives of the selected Air Force courses meet the objectives of civilian schools?

* Do Air Force requirements with regard to prerequisite behavior match those of civilian schools?

* Are the instructional methods of the Air Force courses usable within civilian schools?

* To what extent, if any, must Air Force materials be modified before they can be used within civilian schools?

* What can be said of the cost effectiveness of adapting Air Force materials to civilian education?

* What can be said about the efficiency of the Air Force materials?

* Would Air Force courses affect attitudes of civilian students in a reasonably positive manner?

* To what extent, if any, might the results of the Utah study be applicable to other civilian schools?

As a "laboratory" for this experiment, the state of Utah adds up statistically, according to the latest figures available (1969) from the Utah State Board of Education, as

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1/ Straubel, J. H., Nisos, M. J., and Coffey, J. L., "Initial Feasibility Study for Exploration of Three U. S. Air Force Course Materials for Adaptation to Civilian School Systems", Final Report from Aerospace Educational Foundation to U. S. Office of Education (November, 196[illegible]). 23 pps.

follows: thirty-sixth among the fifty states in total population; second in public school enrollment as a percent of total population; twenty-ninth in estimated average salaries of classroom teachers in public schools; forty-eighth in pupils per classroom teacher in elementary and secondary schools; forty-fourth in personal income per child of school age; thirty-fifth in expenditure per student in federally-aided vocational programs. In brief: a relatively low income, low school budget state with a high pupil to teacher ratio, low teacher salary structure, and a high school enrollment record.

III. PURPOSE OF THE STUDY

The study reported here was designed to put to practical test conclusions of the pilot study that selected Air Force course materials could be used effectively in a civilian setting. The purpose of the study, stated formally, was:

(1) To determine empirically the feasibility of bringing three Air Force instructional systems to bear upon the quantitative and qualitative requirements of civilian education systems as represented by these systems within Utah, and

(2) To assess the extent to which the results obtained within Utah are applicable to civilian education systems nationally.

This study was, first, an examination of the validity of the tentative answers of the pilot study group. It set out to determine by empirical means the compatibility, if any, of Air Force and civilian systems in terms of objectives, prerequisites, strategies, etc. Some modification of the Air Force courses was considered inevitable. Again, a full-scale tryout was expected to answer questions as to the practicality of making the modification -- the time and cost involved, the facilities needed. And finally, through examination of the overall results of the empirical assessment, the study was expected to generate and respond to the question: To what extent are these results applicable to other civilian educational requirements?

The three Air Force instructional system segments -- selected by Utah educators -- and the civilian schools in which they were investigated were:

- A 90-hour segment from the Air Force Standardized Electronic principles Course: at Weber State College, Ogden; Dixie College, St. George; Utah Technical College, Salt Lake City; Utah Technical College, Provo; and Jordan High School, Salt Lake City.

- A 60-hour segment of the Air Force Aircraft Pneudraulic Course: at Utah State University, Logan.

- A 20-hour segment from the Air Force Medical Service Specialist Course: at Utah Technical College, Salt Lake City.

IV. EXPERIMENTAL DESIGN

The experimental design for each of the three programs was completed by Battelle personnel in conjunction with the Utah instructors. As noted, the original intent was that each segment of the study should be of similar design. Since each, in fact, differed from the others, they are described separately.

A. Electronics

The experimental design in this segment of the study accommodated 252 students, the total enrollment in basic electronics at five schools: Weber State College at Ogden, Utah Technical College at Provo, Utah Technical College at Salt Lake City, Dixie College at St. George, and Jordan High School at Salt Lake City. Except for Jordan High School, all schools had three instructional groups: (1) a Control Group, (2) an Experimental Group 1, and (3) an Experimental Group 2. (Inclusion of Jordan High School fulfilled a request from Utah authorities received too late for the three-group design plan to be followed at that institution.) Figure 1 illustrates the general experimental design for electronics.

Instruction given the Control Group throughout the academic quarter resembled that of the comparable 1967-1968 quarter. Experimental Group 1 (Air Force Instruction) received 90-hours of Air Force instruction, followed by an additional block of conventional instruction in mathematics (selected by Utah personnel) not covered by the Air Force instruction. Experimental Group 2 (Augmented Air Force Instruction) differed from Experimental Group 1 in that the same block of additional instruction was interspersed at points selected by Utah personnel.

Jordan High School deviated from the experimental design of Figure 1 because it did not cover the additional instruction in mathematics. Consequently, the high school experimental design simply compared an Experimental Group receiving the 90-hours of Air Force instruction with a Control Group that received the school's conventional instruction.

Proficiency tests were administered three times during the conduct of the study. First, a Pre-test was given to all students during the first class session of each course. Second, a Post-test was administered to all students (referred to, throughout this report, as Post-test I). The Control Group and Experimental Group 2 students received this test on the last day of their courses while those in Experimental Group 1 were given the test immediately after receiving the 90-hour segment of Air Force instruction, and before the mathematics instruction. The third proficiency testing occurred approximately three months after the completion of the course and consisted of a readministration of the Post-test (referred to, throughout this report, as Post-test II). These tests were administered solely by Utah personnel.

Questionnaires designed to assess student interests also were administered by Utah personnel.

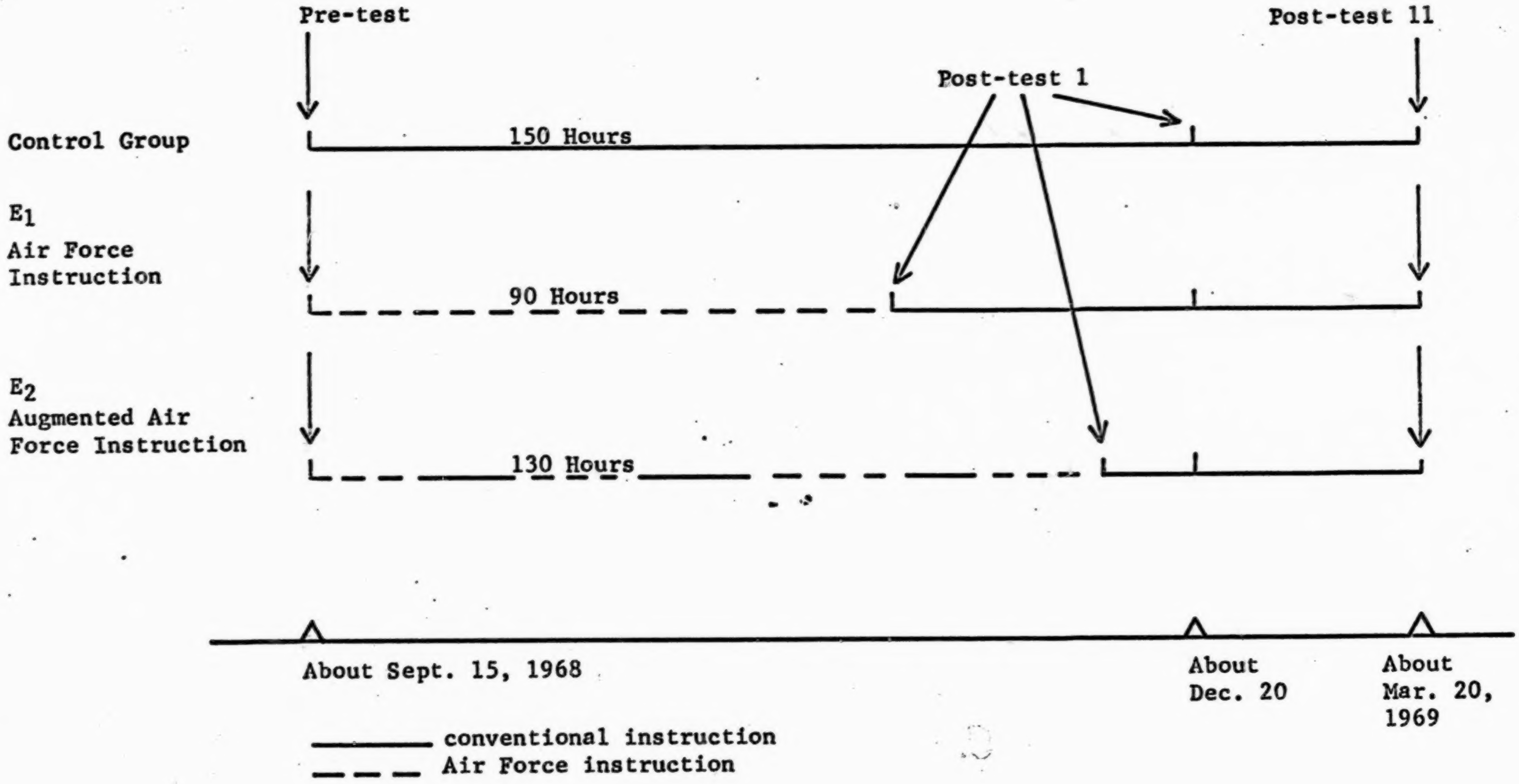
Pre-test
Post-test 11
Post-test 1
Control Group
150 Hours
E1
Air Force
Instruction
90 Hours
E2
Augmented Air
Force Instruction
130 Hours
About Sept. 15, 1968
About
Dec. 20
About
Mar. 20,
1969
conventional instruction
Air Force instruction

Figure 1. Experimental design for electronics instruction.

B. Aircraft Mechanics

The experimental design for the aircraft mechanics instructional program involved students at only one institution, Utah State University. As illustrated by Figure 2, all students received an initial unit of conventional instruction (i.e., instruction given at the host institution during the comparable 1967-1968 period with any changes that might be routinely made). For a second unit of instruction, the students were divided into two approximately equal groups, with 21 students assigned to the Control Group and 22 students to the Experimental Group.

During the treatment period, approximately October 24 through December 3, 1968, the Control Group continued to receive conventional instruction for unit II. The Experimental Group received 60-hours of instruction designed to achieve similar objectives but utilizing Air Force instructional software, items of Air Force equipment (all that was available from military surplus sources; about one-third the number of equipment items prescribed by the Air Force for this course segment) and the equipment normally available at the University. The groups were recombined to receive conventional instruction for the remainder of the academic quarter.

Proficiency data was collected at three points. All students were given a Pre-test just before they were divided into the two treatment groups. Post-test I was given at the completion of the second unit (i.e., just before the two groups were recombined), and Post-test II was administered approximately four months after the post-test.

Throughout the experimental comparisons the instruments designed to assess student attitudes were employed as described earlier.

The instruction, testing, and use of attitude instruments were accomplished by Utah Personnel.

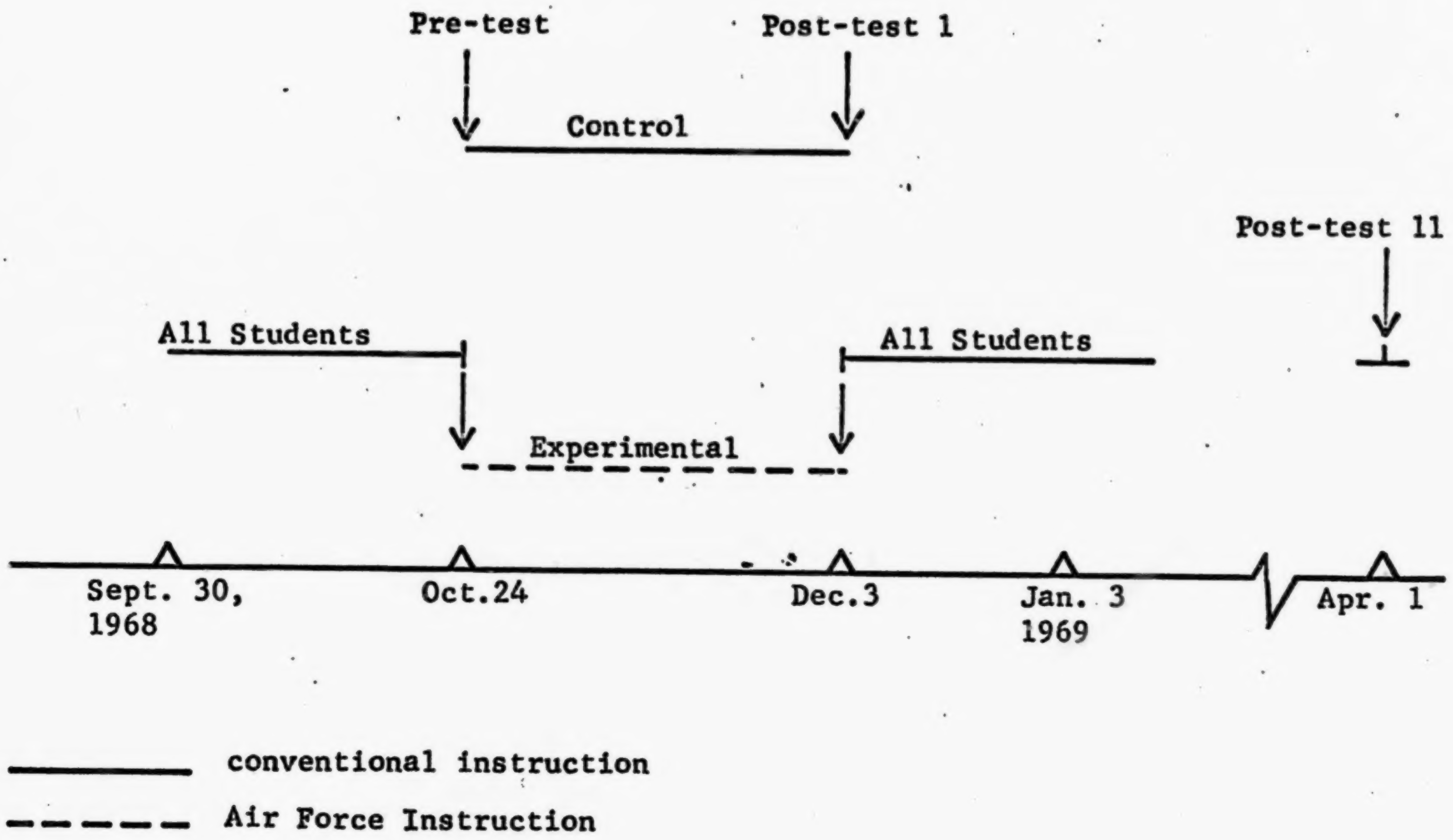
Pre-test
Post-test 1
Control
Post-test 11
All Students
All Students
Experimental
Sept. 30, 1968
Oct.24
Dec.3
Jan. 3 1969
Apr. 1
conventional instruction
Air Force Instruction

Figure 2. Experimental design for Aircraft Mechanics Instruction.

C. Nursing

The experimental design for Nurse's Aide instruction is illustrated in Figure 3. The Experimental Groups began class one week later than the Control Group, since the 31.5 hours of Air Force instruction took considerably less time than the instruction -- covering the same course content -- taken by the Control Group (60 hours). Delaying the Experimental Groups at the beginning of the course allowed all students to continue the post-experimental conventional instruction together.

Regardless of when the classes began, instruction for all groups started with 24 classroom hours of conventional orientation instruction. Following this orientation, the Control Group continued with conventional instruction, while the Experimental Groups received their 31.5 hours of Air Force instruction. At the completion of the experimental period all groups received conventional instruction until Post-test II was administered, approximately one and one-half months later.

The Pre-test, Post-test I and II were administered to all groups. A preliminary and a final questionnaire were also administered to each group. In addition, attitude questionnaires pertaining to the instruction were administered following each program; and, in the case of the Control Group, following each content area consistent with each Air Force program.

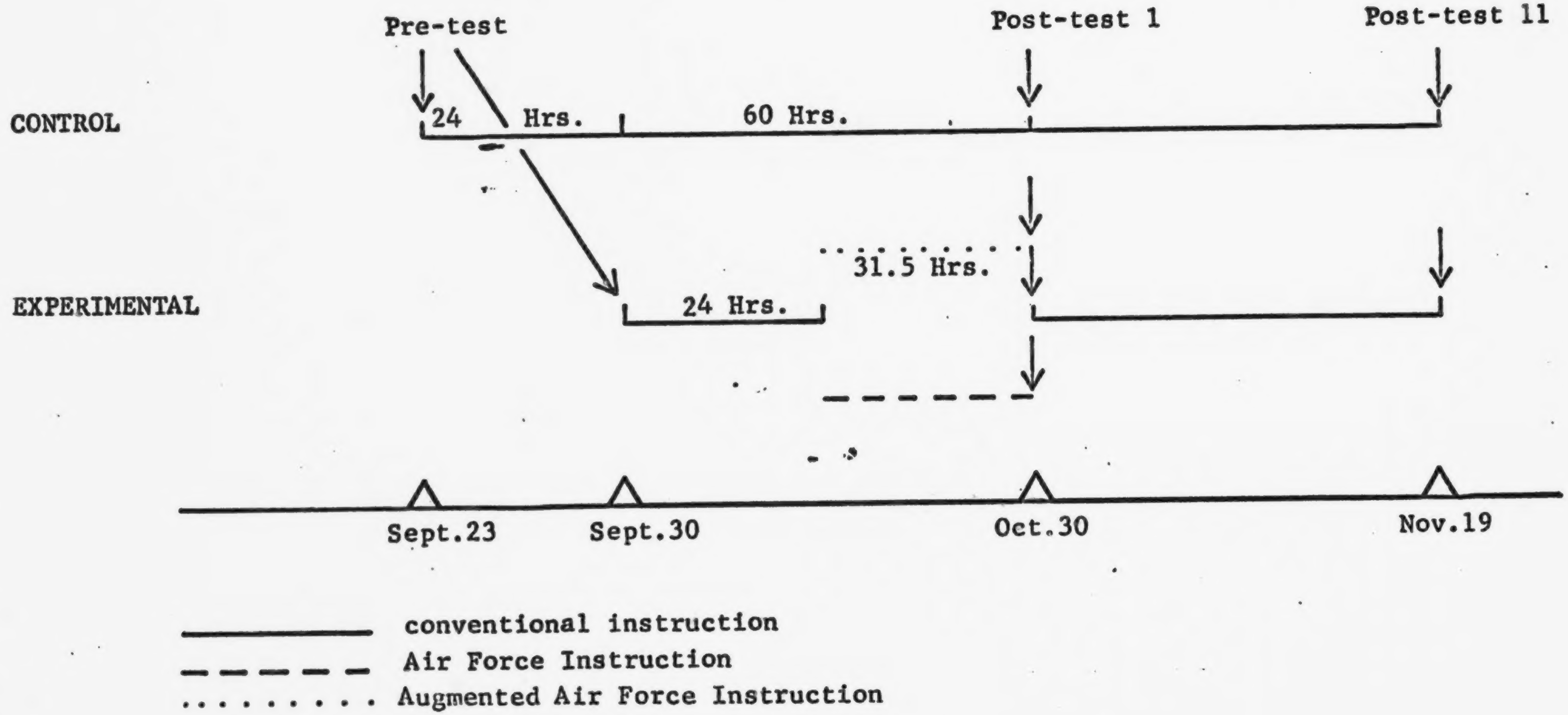
Pre-test
Post-test 1
Post-test 11
CONTROL
24 Hrs.
60 Hrs.
EXPERIMENTAL
24 Hrs.
31.5 Hrs.
Sept.23
Sept.30
Oct.30
Nov.19
conventional instruction
Air Force Instruction
Augmented Air Force Instruction

Figure 3. Experimental design for Nurse's Aide Instruction.

V. MATERIALS

Originally, it was envisaged that each segment of the study would be of similar design. In each, it was proposed that a control group receiving conventional instruction would be compared with two experimental groups, one receiving an unmodified Air Force course and the other a modified Air Force course.

An "unmodified course" was considered to be one in which every effort would be made to replicate the Air Force instructional system. It was assumed that for such a course preparation would involve reproduction of materials, the securing of any equipment considered mandatory for a successful instruction, incorporating the criterion instruments into the system, and so on. It was also recognized that in the "unmodified" course it might be necessary to find alternatives when the requirements for replication were unrealistic (e.g., furnishing an aircraft).

A "modified course," as described in the proposal, would be one in which were incorporated any modifications that appeared to be desirable, effective, and reasonable, but which did not change the fundamental methodologies of the original Air Force instructional system. Such modification would include deletions of Air Force materials considered inappropriate for a civilian course, additions of civilian materials considered to be necessary, amendment of terminology, and adaptations to existing equipment in Utah. (Due to the fact that there were so few actual modifications of Air Force course materials (changes made were primarily supplementary to rather than modifications of these materials) this course segment is referred to throughout this report as Augmented Air Force Instruction.)

In all three segments of the study, Control Groups received one standard instruction of the school -- chiefly live lecture and demonstration. Instructors tried to replicate the courses of the previous year and in no case were students told that they were taking part in an experiment. (There is little doubt, however, that by the end of the study most, if not all, students were aware of the investigation.)

In the experimental groups, somewhat different procedures were followed in each group, depending mainly upon the types of materials used. In all of them, the bulk of the instruction was presented via some medium other than the instructor -- film, programmed texts, workbooks of various types, etc. The instructor's major teaching function in the experimental groups was to supplement this information as seemed necessary.

Each experimental group instructor had a Plan of Instruction (POI) which specified the objectives of the course and indicated the sequence to be followed in using the software and hardware provided. Nothing comparable to a Plan of Instruction existed in the Control Groups.

A. Electronics

For the Control Groups, the predominant instructional method was live lecture and demonstration. The materials used were those normally available for the course: texts, laboratory manuals, charts, and films.

In actuality the experimental system in use departed somewhat from the proposed format. Although the materials used by the experimental groups were initially intended to be those provided by the Air Force, the materials of one group was augmented by segments of conventional instruction. At an early stage, the Utah instructors had pointed out that the Air Force electronics course would not require modification. Upon closer inspection, however, they felt that the Air Force instruction did not parallel their existing course in the depth and scope of mathematics desired. Instructional objectives and an outline for added instruction in mathematics were therefore prepared by Battelle and Utah personnel. For Experimental Group 1, this additional instruction was added at the end of the 90-hour block of Air Force instruction. For Experimental Group 2 the added instruction was interspersed throughout the Air Force instruction.

Additional tasks at this stage of development included reproduction by Battelle of materials such as tests and questionnaires, Air Force manuals, instructor guides, and instructional slides. Battelle technicians also built 75 DC circuit "breadboards," and assembled the power supply kits (purchased by the state of Utah) needed for the laboratory portion of the Air Force Electronics course. (Appendix A).

Also, during this period, three sets of Air Force instructional films were converted from video tape. (Because of the conversion cost, the three sets were shared among the five schools. This was possible because of the proximity of schools and the varied starting dates. Weber State College received one set of films; Jordan High School and Utah Technical College, Salt Lake, shared a second set, and Utah Technical College, Provo, and Dixie College used the third set.)

The experimental courses were based on a series of 37 films, together with related materials such as workbooks, study guides, and 268 35mm slides. (The films and other materials are described more fully in Appendix A). Each Experimental Group instructor had a copy of the Plan of Instruction (POI) for the course. In a typical sequence of instruction, the instructor would introduce the film. From time to time he might stop the film to add an explanation. The films themselves can be said to be programmed in that pauses are inserted in the narrative to give the student time to respond to a question or problem. These responses are recorded in the student's TVI Guide. (The acronym TVI, television instruction, derives from the fact that the Air Force uses videotapes rather than films for presenting these materials.) The TVI Guide is keyed to the instructional sequence and when completed by the student contains a summary of all important points covered.

The showing of the film might typically be followed by a question and answer session conducted by the instructor, a discussion, possibly a demonstration, and a laboratory period.

In addition to the foregoing materials, each student had a Study Guide, essentially a textbook organized to follow the sequence of the film. It contains explanations and, where appropriate, illustrations, of the various concepts. Each section ends with review questions and a summary in the form of objectives which describe the performance expected of the competent student. Each student also had a Student Reference Data Book (containing, for example, tables, color coding chart, etc.) and a Student Workbook. The last contains brief content summaries and homework problems.

B. Aircraft Mechanics

Here, after a closer examination of the desired subject matter -- a segment on aircraft wheels, tires, and brakes -- Battelle and Utah personnel agreed that extremely high equipment costs would be required to adapt this instructional system *a priori*, and this factor would rule out any findings of general interest to civilian education. From alternative segments provided, they chose a segment on aircraft hydraulic/pneudraulic components.

Again, the Control Group used instructional software normally available for its course. These materials do not include a traditional textbook. Instead, the students used manufacturers' manuals detailing the operation, maintenance, and repair procedures for their products; manufacturers' publications outlining hydraulic/pneudraulic principles, plus laboratory assignments outlines, transparencies, filmstrips, handouts, etc.

In selecting experimental materials it was agreed, as in the electronics course, that major modifications of the kind envisaged in the proposal would not be necessary. To meet the needs of the target population, however, it was felt necessary to add depth in some areas and also to increase the instructional scope by adding subject matter not included in the Air Force program. It was further decided that selected items of hardware used by the Air Force but not available in Utah would be desirable.

Contact with the Technical Training Center, Chanute Air Force Base, Rantoul, Illinois, revealed that much of the added depth and some of the added scope could be supplied through use of more advanced Air Force Training Command and/or Air University programs on aircraft pneudraulics. The combination of three existing programs resulted in the development of a 60-hour instructional-system segment.

Attempts by the Aerospace Education Foundation to procure the desired additional items of Air Force hardware through surplus equipment channels led to acquisition of only part of the desired items (about one-third the hardware used by the Air Force for these course segments). The items obtained notably reduced the equipment discrepancy that had existed but were not sufficient to justify the setting up of two experimental groups in which the utilization of the additional hardware was the variable. This, coupled with a student enrollment that was lower than expected, led to a decision to use only two treatment groups -- a control group receiving conventional instruction and using existing hardware, and an experimental group receiving the Air Force instructional programs, using existing hardware and the newly acquired hardware.

The software ultimately used by the Experimental Group included 12 instructional units from a basic course for Aircraft Pneudraulic Repairman, five instructional units from an advanced level course for Aircraft Pneudraulic Repair Technician, both courses from the Air Training Command, and nine segments from an intermediate Air University course normally used in Air Force on-the-job training. The instructors also had available a variety of aids used by Air Force instructors, including lesson plans, slides, and technical orders. As mentioned earlier, the experimental group also used equipment obtained through government surplus channels. (Details of these materials are given in Appendix B).

C. Nursing

Live lecture and demonstration were the predominant instructional techniques for the Control Group of the nursing segment of the study. The software used included one text and several charts (Appendix C).

In making their selection of Air Force resources, Utah and Battelle personnel began with an examination of the Medical Services Specialist instructional system at Sheppard Air Force Base, Texas. Utah personnel deleted sections of the instruction as being unrelated to civilian use and also extended the time allotted to six of eight selected programs. (See Table 1). An alternative (modified form of the Air Force materials) was then developed by changing all military terms to civilian terms.

The burden of instruction for the Experimental Groups was carried by a series of transparencies and a film. For each Experimental Group the instructor was provided with a Plan of Instruction (POI) which specified the objectives of the course and the sequence for using the instructional software.

In a typical sequence of instruction, the instructor would introduce the tape, students would receive an explanation and, where appropriate, a demonstration, from the written and visual materials. Students then would be asked by the instructor to perform the operation for themselves. The instructor would check performance against the criteria specified and provide feedback and additional help as necessary.

TABLE 1

SUMMARY OF EXPERIMENTAL SEGMENTS

FOR THE NURSE'S AIDE COURSE

Programs	Original AF Hours	Revised Utah Hours
Sterile Equipment and Supplies	1	1
Common Disease-Causing Organism	2	3
Surgical Aseptic Technique	2	3
Medical Aseptic Technique	2	3
Medical Terminology	3	5
Comfort and Hygiene	7.5	12
Diets	2	1.5
Lifting and Moving Patients	1	3
Total Hours	20.5	31.5

VI. STUDENTS

A. Electronics

This segment of the study included 252 students, the total enrollment in basic electronics at five schools: Weber State College, Utah Technical College at Provo, Utah Technical College at Salt Lake City, Dixie College, and Jordan High School. Except for Jordan High School, all schools had three instructional groups: (1) a Control Group, (2) an Experimental Group 1 (Air Force Instruction), and (3) an Experimental Group 2 (Augmented Air Force Instruction). (As noted, Jordan High School was included in the project too late for incorporation of the three-group design plan). The initial allocation of students by treatment condition is shown in Table 2.

Except at Utah Technical College, Salt Lake, students were assigned to treatment conditions on a random basis. No student was told he would be participating in a research project. The most common assignment technique was to allow each student to register for the course that was most convenient for him. At Utah Technical College, Salt Lake, an entrance electronics test was administered to all beginning electronics students. Data from this entrance test was used in an A B C/C B A design to assign students to the three treatment conditions. The student receiving the highest entrance test score was placed in the Control Group, the second highest was assigned to Experimental Group 1, the third and fourth highest went to Experimental Group 2, the fifth to Experimental Group 1, the sixth to the Control Group, etc.

TABLE 2

NUMBER OF INITIAL STUDENTS BY SCHOOL
IN ELECTRONICS COURSE

School	Treatment Condition		
	Control	Experimental Group I	Experimental Group 2
Utah Technical College - Salt Lake	31	28	30
Utah Technical College Provo	18	16	17
Weber State College	14	21	16
Jordan High School	21	24	-
Dixie College	4	4	8
Total	88	93	71

Table 3 shows the number of students in each group who had or did not have an electronics hobby, while Table 4 shows the number of students who did or did not have an electronics course previous to the experimental treatment period. (The N's of Tables 2, 3, and 4 differ because not all students answered all items of the Preliminary Questionnaire.) The three groups did not differ significantly in terms of the proportion of students who had had previous electronics instruction; however, a greater proportion of students in Experimental Group 2 than in the other groups had an electronics hobby.

Results of the Preliminary Questionnaire show that the ages of the students in the various groups did not differ significantly.

TABLE 3

NUMBER OF STUDENTS WHO HAD AND DID NOT HAVE AN ELECTRONICS HOBBY

Schools	Treatment Condition					
	Control		Experimental Group 1		Experimental Group 2	
	With	Without	With	Without	With	Without
Utah Technical College - Salt Lake	6	24	9	19	12	17
Utah Technical College - Provo	7	8	3	12	9	8
Weber State College	9	3	13	7	9	7
Jordan High School	5	14	9	14	*	*
Dixie College	**	**	**	**	5	3
Total	27	49	34	52	35	35

* No Experimental Group 2 was available.

** Preliminary Questionnaire data were unavailable.

TABLE 4

NUMBER OF STUDENTS WHO HAD AND DID NOT HAVE PREVIOUS ELECTRONICS INSTRUCTION

	Treatment Condition					
Schools	Control		Experimental Group 1		Experimental Group 2	
	With/Without		With/Without		With/Without	
Utah Technical College - Salt Lake	12	17	9	15	8	22
Utah Technical College - Provo	6	8	2	13	2	14
Weber State College	3	9	10	5	8	8
Jordan High School	1	17	3	19	*	*
Dixie College	**	**	**	**	1	6
Total	22	51	24	52	19	50

* No Experimental Group 2.
** Preliminary Questionnaire data unavailable.

B. Aircraft Mechanics

The 43 subjects, all males, in this segment of the study were all of the students enrolled in Course ITE 118 Aircraft Hydraulics and Servomechanisms in the Department of Industrial and Technical Education, Utah State University, Logan, Utah.

Because scheduling conflicts made it impossible to completely randomize the assignment of students to treatment groups, the groups were sampled on five measures that might interact with student performance.

The Control Group, containing 21 students, and the Experimental Group, with 22 students, did not differ significantly on three dimensions sampled in the Preliminary Questionnaire: i.e. age, high school GPA, post high school GPA. On the remaining two dimensions, however, the groups did differ beyond the chance level. The proportion of students who had previously taken a similar course, and the proportion of students having an aircraft mechanics related hobby was significantly higher ($P < .05$) in the Control Group than in the Experimental Group. Table 5 contains a descriptive data summary on the target populations. (N's for all groups do not agree because not all students completed all items of the questionnaire.)

Table 5

DESCRIPTIVE STATISTICS FOR AIRCRAFT MECHANIC GROUPS

Statistics		Control Group	Experimental Group
Group Size:	Pre-test	N=21	N=22
	Post-test	N=19	N=22
	Retention Test	N=15	N=20
Students Who Dropped Course		N=2	N=0
Students With Related Course		6	3
Students Without Related Course		14	19
	Sample Size	20	22
Students With Related Hobby		16	17
Students Without Related Hobby		4	5
	Sample Size	20	22
Age:	Mean	22.8 years	23.1 years
	Median	27.1 "	22.0 "
	Range	1.8 "	7.0 "
	SD[1]	4.45 "	4.33 "
	Sample Size	20	22
High School GPA: (4 point scale)	Mean	2.87	2.79
	Median	3.0	3.0
	Range	2.0	1.5
	SD[1]	587	483
	Sample Size	19	18
Post High School GPA: (4 point scale)	Mean	2.49	2.40
	Median	2.40	2.48
	Range	1.85	2.33
	SD[1]	478	455
	Sample Size	19	21
Class Breakdown:	Freshmen	-	-
	Sophomores	2	4
	Juniors	7	7
	Seniors	4	8
	Grad. Students	1	1
	Sample Size	14	20

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[1] Adjusted for small sample

C. Nursing

Students enrolled in the beginning Nurse's Aide course at Utah Technical College, Salt Lake City, were to serve as subjects in the study, with all student selections made by Utah authorities. Because so few students enrolled initially, free tuition was offered several other students in an effort to increase enrollment. Because of the difficulty in recruiting students, there was a significant education imbalance in the groups. All members of the Control Group had at least a high school education, and some a year of college. No member of the Experimental group had completed high school. A social imbalance in the groups is reflected in the fact that all members of the Control Group were housewives with husbands who were wage earners; while there were no housewives in the Experimental Group, and all but one of its members were on welfare rolls.

Of the 20 students, nine were initially assigned to the Control Group, six to Experimental Group 1 (Air Force Instruction), and five to Experimental Group 2 (Modified Air Force Instruction). Table 6 shows mean age of students for each treatment condition. The wide range of ages between students of the control and treatment conditions is apparent, and probably explains the lack of a statistically significant difference between the age means.

Table 7 presents the number of students in each group who had and did not have a hobby or activities related to nursing. The three groups did not differ meaningfully in proportion of students who had engaged previously in nursing-related activities.

TABLE 6

AGES OF STUDENTS IN NURSE'S AIDE COURSE

	Control Group	Experimental Group E_1	Experimental Group E_2
Mean Age	40.4	32.0	32.4
Range	30 - 50	19 - 54	19 - 47
N	9	6	5

TABLE 7

NUMBER OF STUDENTS WHO HAD AND DID NOT HAVE A HOBBY OR ACTIVITIES RELATED TO NURSING

	With	Without
Control	2	7
Experimental Group 1	0	6
Experimental Group 2	1	4

VII. MEASURING INSTRUMENTS

A. Tests of Student Proficiency

Alternate forms of a criterion measure of student proficiency were provided for each segment of the study. In the aircraft mechanics program, the two tests consisted entirely of test items supplied by the Air Force. In the other two programs, Battelle and Utah personnel constructed items to supplement those supplied by the Air Force.

(The Air Force test items -- and, indeed, the design of the instructional materials -- are based on one of the early products of instructional system design: statements of learning objectives (known to the Air Force as SOLO's). All Air Force test items are keyed to a SOLO, but test items do not exist for all SOLO's.)

Battelle/Utah developed test items were used in all instances where the pool of Air Force-developed items was not sufficient for construction of the two desired test forms. Items were assigned to the two test forms as follows: Where two or more Air Force items existed for a SOLO, one item was randomly assigned to Form A and a second to Form B. For any SOLO for which both items were Battelle/Utah-developed, random assignment was again used. For SOLO's for which one Air Force and one Battelle/Utah item existed, half of the Air Force and half of the Battelle/Utah items were assigned to each form.

Periodic progress tests were considered for the electronics and aircraft mechanics courses, but the idea was abandoned, mainly because it was felt that such testing would markedly obscure any differences attributable to the treatment variable, the instructional system. In addition, it was felt that progress testing would have sharply decreased teacher-student contact time.

B. Providing Instruments for Assessing Student Interests

A number of questionnaires were administered in all three segments of the study in an attempt to obtain measures in the affective domain. Not all measures were used in all three segments, however. (See Table 8).

Preliminary questionnaire

All students in all groups received this questionnaire. In addition to historical data (e.g., age, previous experience with the subject matter, prior academic achievements, etc.), the questionnaire sought to establish a student's entering interests by asking about hobbies or activities related to the course and how many hours per month he had devoted to the hobby or activity over the last year.

Weekly questionnaire

This questionnaire, administered during the last class meeting of each week to all students, was designed to measure weekly shifts in attitudes. It asked each student to rate the course as to: (a) interest of instruction, (b) informativeness of instruction, (c) his performance, and (d) the instructor's performance.

Terminal questionnaires

Two forms of the terminal questionnaire were administered in each program, one for students in the control groups (conventional instruction) and the other for those in the experimental groups. The forms differed only in the deletion of several items in the "experimental" form that were irrelevant for control students. Most deleted items sampled responses to instructional software (e.g., films, programmed instruction) used only by the experimental groups.

Retention questionnaire

This instrument, which was not administered in the nursing program, asked students to rate how adequately they felt their instruction during the study met their subsequent training needs. Students were also asked to rate their enjoyment of and performance in the course during the study period and to compare the difficulty of that part of the course with subsequent training. Those who had used the experimental materials were asked to state their preference for the methods used and to state whether or not they would enroll in another course similarly taught.

Attendance record

This record, kept by the instructors, logged absence and tardiness.

Optional assignment record

Instructors were asked to log a description of any optional assignments completed and the grade awarded.

Instructor comment record

Instructors teaching the experimental programs noted major deviations from their planned instructional strategy, favorable or unfavorable features of the program, and personal observations.

TABLE 8

INSTRUMENTS ADMINISTERED TO STUDENTS OF THE THREE COURSES

	Electronics	A/mechanics	Nursing
1. Preliminary questionnaire	X	X	X
2. Weekly questionnaire	X	X	
3. Terminal questionnaire, Control Group	X	X	X
4. Terminal questionnaire, Experimental Group(s)	X	X	X
5. Retention questionnaire	X	X	
6. Attendance record	X	X	X
7. Optional assignment record		X	
8. Instructor comment record	X	X	X

VIII. PROCEDURE

Immediately before the actual conduct of the study, the Battelle staff conducted a final briefing for all instructors involved in it. The briefings were designed to help insure uniformity of procedure in the various segments of the study, to answer last-minute questions, and to provide a final check on Instructional software and hardware.

In the aircraft mechanics course, Battelle staff also observed the initial classes of both treatment groups and the initial laboratory exercise to ensure that the software was correctly used.

Since each segment of the study differed from others in matters of detail, each is discussed separately.

A. Electronics

Each of the five schools retained its typical class period arrangement during the conduct of the study. For example, if a school's electronics class usually met five times a week with one-hour class periods, the school maintained this schedule throughout the course for all groups. Because of this, no school exactly replicated the 6-hour-per-day schedule followed by the Air Force. Additionally, the high school had to compress the 90-hours of Air Force instruction into approximately 80-hours of class time. Although the Air Force schedule was not duplicated, it was felt that the procedure followed was typical of what would happen in attempting to use Air Force materials in civilian environments.

It was left to the schools to determine which instructor would teach each group. Other than the fact that two relatively inexperienced teachers had to be used for the experimental groups, there seemed to be no meaningful differences among the groups in terms of instructor capability. One significant problem did arise at Dixie College, however. There, because of the relatively small enrollment, it was decided to use only two, rather than three, instructors. The problem was further compounded by the assignment of one instructor to teach both the Control Group and Experimental Group 1.

At registration, no student was informed that he would be involved in an experimental investigation of instructional systems. Throughout the treatment period every effort was made to avoid discussion concerning the novel instructional materials and procedures, although no attempt was made to directly deceive the students. It is suspected that many students became aware that they were involved in an experiment. Additionally, there was some verbal interchange among the students at each school. The amount of such interchange is not considered sufficient to seriously confound the results.

During the first course meeting of each group, all students were administered the 146-item pre-test criterion performance measure, half of each treatment group receiving Test Form A and the rest receiving Test Form B. All students completed a Preliminary Questionnaire which requested background data (e.g., age, previous academic record, related hobbies, etc.).

During the treatment period four weekly records were completed: students completed an attitude questionnaire, and instructors completed an Attendance Record, an Optional Assignment Record, and a Weekly Instructor Comment Sheet.

At the end of the treatment period, each student was administered the post-test and also the Terminal Questionnaire.

As specified in the experimental design, each student was also to complete the post-test approximately three months after its first administration. Typically, students involved in the electronics segment of the study enrolled in a subsequent electronics course, making it fairly simple to schedule this test. A last-minute scheduling conflict did occur at Jordan High School, however, and the second post-test was not administered during the school year. An attempt to administer the test by mail during the summer vacation was only moderately successful. Additionally, as would be expected, all schools had some students who withdrew during the period between the two post-tests.

As discussed elsewhere, two equivalent forms of the criterion performance were developed by Battelle staff. For Post-test II, each student received the same form of the measure as he received for Post-test I. Thus, one-half of the Control Group received test form sequence A-B-B (i.e., Pre-test, Post-test I, Post-test II) while the other half of the Control Group received test form sequence B-A-A. The Experimental Groups were administered the Pre-, Post I, and Post II test sequence in an identical split-half manner.

In addition to Post-test II, each student was asked to complete the retention questionnaire. This questionnaire, designed primarily to sample the stability of the responses obtained in the Terminal Questionnaire, included many items sampling the students on their response to various factors of their particular instructional system, their own performance, and their instructor's performance.

B. Aircraft Mechanics

Aeronautical Technology Course ITE 118 is a one quarter undergraduate course offered annually at the Utah State University, Logan, Utah. A four credit course, it typically meets twice a week for one and one half hours of teacher-led presentation/discussion. In addition, each student signs up for one of two scheduled laboratory sessions, each of which meets weekly for at least two hours. During this project, class sessions were held on Tuesday and Thursday mornings and laboratory sessions offered on Tuesday and Thursday afternoons.

ITE 118 began late in September, 1968, with an enrollment of 43 male students. For about a month, all attended the same conventional classes and approximately half of the class attended the Tuesday laboratory session and the rest attended the Thursday laboratory session. During this period, all classroom instruction was handled by the Control Group instructor. He also supervised one lab session while the other was directed by the Experimental Group Instructor.

During the classes on October 3 and 8 all students were administered one form of the 111-item criterion performance measure as a pre-test. Half of each treatment group received Test Form A and the other half received Form B.

At this time, all students also completed a Preliminary Questionnaire which requested certain background data (e.g., age, previous academic record, related hobbies, etc.).

At the close of the October 27 meeting it was announced that for the next six-week block of instruction, students would be divided into two groups. Each student was assigned to one of two instructors. No one was told of the experimental nature of this procedure. When questioned, the instructors replied that they wanted to try a different instructional approach.

On the first day at the treatment period the Control Group instructor proceeded as usual but the Experimental Group Instructor began by distributing the Air Force instructional software and explained how the three packages were to be utilized. Again, no comment was made about the experimental nature of the instruction and the instructor answered questions about the software in this manner: "I used material like this when I was in the Air Force and found it very effective. I thought I would try it now."

Although every effort was made to avoid discussion about the unusual instructional materials and procedures, no attempt was made to directly deceive students. About three-fourths of the way through the treatment period both the Experimental and Control Groups had concluded that an experiment was in progress and that the relative effectiveness of the novel instructional software was the main treatment variable.

During the six-week treatment period, four weekly records were completed:

(1) The subjects completed a weekly questionnaire which sampled changes in attitude;

(2) Instructors maintained an Attendance Record;

(3) Instructors also maintained an Optional Assignment Record (due to the heavy regular load no students requested optional assignments), and

(4) Instructors completed a Weekly Instructor Comment Sheet on the features, problems, student reactions, deviations from the scheduled outline.

At the end of the treatment period, each student was administered the Post-test. During the class period preceding the Post-test, each student completed the Terminal Questionnaire.

On completion of the six-week (twelve-class meetings) treatment period and the administration of the post-tests and Terminal Questionnaire, the groups were again joined and all the students received their instruction for the remaining two weeks from the Control Group instructor.

As specified in the experimental design, each student also was expected to complete Post-test II approximately three months after the administration of Post-test I. In fact, the latter was administered on April 1, 1969, roughly four months after the first post-test. The unanticipated delay was due to teacher/student scheduling problems and the difficulties in locating students who were not registered for aeronautical technology courses during the Spring Quarter. Through the cooperation of instructors both in and outside the aeronautical technology program in providing release time, most students were able to complete the scheduled post test session. Six students could not be located to take the second post test: four from the Control Group and two from the Experimental Group.

As previously discussed, different but equivalent forms of the criterion performance test were developed by the Battelle project staff, utilizing items procured from the Air Force and Air University. For the second post test each student received the same form of the criterion measure as he received for the first post-test. Thus, one half of the Control Group received test form sequence A-B-B while the other half received test form sequence B-A-A. The Experimental Group was administered the Pre-, Post I-, and Post II-test sequence in an identical split-half manner.

In addition to Post-test II, each student was asked to complete a retention questionnaire. This questionnaire, designed primarily to sample the stability of the responses obtained in the Terminal Questionnaire, included many items which sampled the students on their response to various factors of their particular instructional system, their own performance, and their instructor's performance.

C. Nursing

The study of the Nurse's Aide program took place primarily at the Utah Technical College, Salt Lake City. Several laboratory sessions were conducted at nearby hospitals. A total of 20 students were enrolled initially.

The allocation of instructors to groups was left to the discretion of the director of the Nurse's Aide program. It was felt that there was little difference between the two instructors' capabilities.

The two Experimental Groups were in the same class throughout the experimental period. The Control Group was in a separate class.

Students were not told at registration that they would be involved in an experiment. Throughout, every effort was made to avoid discussion of unusual instructional materials or procedures, although no attempt was made to deceive students.

All students were given the Pre-test criterion performance measure at their first class meeting, half receiving Test Form A and the remainder Test Form B. They also completed a Preliminary Questionnaire which requested background data.

During the treatment period, instructors maintained an Attendance Record and a Weekly Instructor Comment Sheet on features, problems, student reactions, and deviations from the scheduled outline.

At the end of the treatment period all students were administered the Post-test and also completed the Terminal Questionnaire.

In addition, each student was asked to complete Post-test II after completion of the entire Nurse's Aide Course -- approximately one and one half months later.

Two different but equivalent forms of the criterion performance test were developed by the Battelle project staff. For Post-test II, each student received the same form he received for Post-test I. Thus, one-half of the Control Group received test form sequence A-B-B (i.e., Pre, Post I, Post II) while the other half of the Control Group received test form sequence B-A-A. The Experimental Groups were administered the Pre-, Post I-, and Post II-test sequence in an identical split-half manner.

Scheduling prevented administering of the Retention Questionnaire.

IX. RESULTS

A. Electronics

Scores from an initial test and two post-tests for three groups of students were compared. Experimental Group 1 (Air Force Instruction) received the Air Force instructional program and, following Post-test I, received an additional block of conventional instruction in mathematics. Experimental Group 2 (Augmented Air Force Instruction) received the Air Force instructional program augmented by blocks of conventional instruction interspersed at four different points in the instructional program. The Control Group (Traditional Instruction) received the regular electronics program that had been used at each school the previous year. All the students began the course on AC circuits as soon as their DC course was completed.

Initial Test Results

An initial test was administered to all instructional groups on the first day of instruction. Half of the students in each group took Form A of the test; half took Form B. Results are shown in Table 9.

The performance of two of the groups differed significantly at the outset of the experimental program. Performance of students assigned to Augmented Air Force Instruction was significantly higher than the performance of students assigned to Traditional Instruction. Performance of students assigned to Air Force Instruction did not differ significantly from that of the students assigned to either of the other instructional groups.

The mean score for the 71 students assigned to Augmented Air Force Instruction was 63.2 (S.D. = 24.4) compared with a mean score of 54.3 (S.D. = 25.8) achieved by the 88 students assigned to Traditional Instruction. $\underline{t}$ for the 9.9 difference between means was 2.21 (df = 157), which is significant at the 5% level of confidence.

The mean score for the 93 students assigned to Air Force Instruction was 58.4 (S.D. = 24.2). The difference between the means for this group and the Augmented Air Force Instruction group was 4.8; t was 1.24 (df = 162), which is not significant at the 5% level. The difference between means for the Air Force Instruction group and the Traditional Instruction group was 4.1; $\underline{t}$ was 1.10 (df = 179), which is not significant at the 5% level of confidence.

Post-test I Results

For Post-test I, each student received the alternate of the test form taken for the initial test. Students who received Augmented Air Force Instruction and Traditional Instruction took Post-test I during the last day of the course. Students who received Air Force Instruction took Post-test I after completing the 90-hours of Air Force Instruction, but prior to receiving the block of conventional instruction in math. Results of Post-test I are shown in Table 9.

Students who received the Augmented Air Force Instruction achieved the highest mean score, which was 111.4 (S.D. = 17.2). Students who received Air Force Instruction were next with a mean score of 104.2 (S.D. = 23.1). Students in the traditional electronics program achieved the lowest scores, the mean being 94.6 (S.D. = 20.5).

The difference between means for Air Force Instruction and Augmented Air Force Instruction groups was 7.2; t was 2.17 (df = 148), which is significant at the 5% level of confidence. The difference between means for Air Force Instruction and Traditional Instruction groups was 9.6; t was 2.78 (df = 160), which is significant at the 1% level of confidence.

The difference between means for Augmented Air Force Instruction and Traditional Instruction groups was 16.8; t was 5.27 (df = 140), which is significant beyond the 1% level of confidence. Since these two groups differed at the outset, strictly speaking, the comparison serves to show only that original differences had not been obscured. Nonetheless, it is evident that the group receiving Augmented Air Force Instruction achieved significantly higher scores than the group receiving Traditional Instruction. The reason for this conclusion is that the mean score of the Augmented group was significantly higher than the mean score of the Air Force Instruction group; and the latter in turn, was significantly higher than the mean for the Traditional Instruction group.

Post-test II Results

Post-test II was administered approximately three months after instruction was completed. Nearly half of the students were unavailable for this test, however. In a number of cases, the tests were mailed to the students, taken under unknown conditions, and returned to the instructors by mail.

Each student took the same form of the test he had taken for Post-test I. Results are shown in Table 9.

(Air Force Instruction students received a block of conventional instruction in math following Post-test I. During the time intervening between the two post-tests all groups continued with Traditional Instruction in AC electronic theory.)

Performance of students receiving Augmented Air Force Instruction was higher than the performance of students receiving either Air Force Instruction followed by a block of conventional instruction in math or students receiving Traditional Instruction. Performance of the latter two groups on Post-test II was similar.

The mean score for the 41 students who received Augmented Air Force Instruction and who took Post-test II was 113.9 (S.D. = 18.6), while the 58 students who received Air Force Instruction achieved a mean score of 105.4 (S.D. = 22.0). The mean score for the 44 students available from the Traditional Instruction group was 101.6 (S.D. = 20.2).

The difference between means for the Augmented Air Force Instruction and Air Force Instruction groups was 8.5, $\underline{t}$ was 2.04 (df = 97), which is significant at the 5% level of confidence. The difference between means for the Air Force Instruction and the Traditional Instruction groups was 3.8; $\underline{t}$ was 0.90 (df = 100), which is not significant at the 5% level.

The difference between means for the Augmented Air Force instruction and Traditional Instruction groups was 12.3; $\underline{t}$ was 2.87 (df = 83), which is significant at the 5% level of confidence. The results indicate only that original differences had not been obscured by the instructional programs.

TABLE 9

RESULTS OF THE INITIAL TEST AND POST-TESTS I AND II
FOR STUDENTS IN THREE INSTRUCTIONAL GROUPS

	Traditional Instruction		Air Force Instruction		Augmented Air Force Instruction	
Initial Test						
Mean	54.3		58.4		63.2	
S.D.	25.8		24.2		24.4	
N	88		93		71	
D		4.1		4.8		8.9*
t		1.10		1.24		2.21
df		179		162		157
Post-test 1						
Mean	94.6		104.2		111.4	
S.D.	20.5		23.1		17.2	
N	77		85		65	
D		9.6		7.2		16.8*
t		2.78***		2.17**		5.27***
df		160		148		140
Post-test II						
Mean	101.6		105.4		113.9	
S.D.	20.2		22.0		18.6	
N	44		58		41	
D		3.8		8.5		12.3*
t		0.90		2.04		2.87**
df		100		97		83

* Comparison of Augmented Air Force and Traditional Instructional Group

** $p < .05$

***$p < .01$

Gain Scores

Gain scores between Pre-test and Post-test I scores were computed for each group by the following formula:

$$\text{Gain Score} = \frac{\text{Actual Performance gain}}{\text{Possible Performance gain}} \times 100$$

In this formula, actual performance gain was taken as the difference between scores on Post-test I and the initial test, while possible performance gain was the difference between the total possible score and the actual score on the initial test.

As seen in Table 10, students who received the Augmented Air Force Instruction had the highest gain scores, while students receiving Air Force Instruction received the next highest gain scores. Students who received Traditional Instruction had the lowest gain scores. Mean gain scores for the three groups of students, for all five schools, were 57.5, 53.9, and 41.6, respectively.

$\underline{t}$ tests were completed for pairs of these means (see Table 11). The comparisons for groups C and E_1, and between C and E_2, show a $\underline{t}$ of 4.53 (df = 156) and 6.15 (df = 136). Both $\underline{t}$'s are significant beyond the 1% level of confidence. The difference between the mean gain scores of groups E_1 and E_2 was 1.26 (df = 148), which is not significant. These results show that both experimental groups gained significantly more in performance capability as a result of instruction than did the Control Group.

TABLE 10

MEAN GAIN SCORES BETWEEN PRE-TEST AND POST-TEST I FOR THREE GROUPS RECEIVING ELECTRONICS INSTRUCTION

	C Traditional Instruction	E_1 Air Force Instruction	E_2 Augmented Air Force Instruction
Mean	41.6	53.9	57.5
S.D.	14.5	19.3	15.5
N	73	85	65

TABLE 11

COMPARISONS OF MEAN GAIN SCORES FOR THREE GROUPS RECEIVING ELECTRONICS INSTRUCTION

Groups Compared	*t*	df	p
C and E_1	4.53	156	$<.001$
C and E_2	6.15	136	$<.001$
E_1 and E_2	1.26	148	non-sig.

Comparison of Students Having and Not Having Electronics-Related Hobbies

Information about hobbies related to electronics was available for many of the students. Scores of students having and not having hobbies related to electronics within each of the instructional groups were compared on each of the three tests -- Pre-test and Post-tests I and II. These comparisons are shown in Table 12.

Initially, students having electronics-related hobbies scored significantly higher than students without such hobbies regardless of treatment group. At the time of Post-test I, however, the difference between these subgroups was no longer significant for the Air Force Instruction group. At the time of Post-test II, only the subgroups within the Augmented Air Force Instruction group differed significantly.

Comparison of Students Having and Not Having Prior Course Work in Electronics

Information about prior course work in electronics was available for most of the students. Scores of students with and without prior instruction in electronics within each of the instructional groups were compared on each of the three tests -- Pre-test and Post-tests I and II. These comparisons are shown in Table 13.

Students having previous course work in electronics scored significantly higher than students without previous course work within each of the instructional groups on all three tests. Inspection of the results shown in Table 13 suggests that the effects of previous course work are greater on Pre-test performance and the instruction may reduce some of these differences, since the magnitude of the obtained differences were greater on the Pre-test than on subsequent tests. Results of Post-test I and II suggest that previous course work is a factor in retention of performance after termination of instruction. The magnitude of the obtained differences were greater on Post-test II than on Post-test I for all instructional groups. Further, type of instruction does not appear to have a differential effect.

TABLE 12

COMPARISON OF SCORES ON PRE-TEST AND POST-TESTS I AND II OF STUDENTS WITH AND WITHOUT ELECTRONTICS-RELATED HOBBIES WITHIN EACH OF THREE INSTRUCTIONAL GROUPS

	Traditional Instruction		Air Force Instruction		Augmented Air Force Instruction	
	With Hobby	Without Hobby	With Hobby	Without Hobby	With Hobby	Without Hobby
Initial Test						
Mean	71.7	43.7	68.5	50.5	74.5	51.5
S.D.	27.7	19.9	27.5	17.8	24.7	18.2
N	27	49	34	52	35	35
D	28.0		18.0		23.0	
t	4.56***		3.34***		4.37***	
df	74		84		68	
Post-test I						
Mean	102.4	88.0	106.7	104.5	115.9	105.6
S.D.	22.9	18.1	19.7	22.4	15.7	17.2
N	26	40	31	47	34	30
D	14.4		2.2		10.3	
t	2.66**		0.45		2.45**	
df	64		76		62	
Post-test II						
Mean	106.3	94.9	104.5	104.9	121.1	103.8
S.D.	21.7	19.7	22.2	21.5	10.4	22.7
N	19	19	24	31	23	17
D	11.4		-.4		17.3	
t	1.65		0.07		2.84***	
df	36		53		38	

* $p < .05$
** $p < .01$
*** $p < .005$

TABLE 13

MEAN PROFICIENCY AND t-TEST SCORES FOR STUDENTS WITH AND WITHOUT A RELATED COURSE

	Traditional Instruction		Air Force Instruction		Augmented Air Force Instruction	
	With Course	Without Course	With Course	Without Course	With Course	Without Course
Initial Test						
Mean	66.1	49.2	75.3	46.6	77.7	57.7
S.D	24.9	26.0	21.4	17.3	25.0	22.0
N	22	51	24	52	19	50
D	16.9		28.7		20.0	
t	2.58**		5.66***		2.99***	
df	71		74		67	
Post-test I						
Mean	102.2	89.6	116.4	99.2	119.7	108.2
S.D.	20.2	21.1	15.1	20.6	14.4	17.2
N	21	43	21	48	18	45
D	12.6		17.2		11.5	
t	2.26*		3.81***		2.64***	
df	62		67		61	
Post-test II						
Mean	108.9	95.8	117.4	97.4	125.9	109.2
S.D.	17.6	22.0	14.2	21.1	7.0	19.9
N	14	24	17	31	11	29
D	13.1		20.0		16.7	
t	1.96*		3.82***		3.83***	
df	36		46		38	

* $p < .05$
** $p < .01$
*** $p < .005$

Student Interest

Student interest was inferred from ratings on three questionnaires and from class attendance records. Students completed weekly questionnaires, a terminal questionnaire, which was completed upon termination of instruction, and a retention questionnaire, completed at the time of Posttest II.

Weekly Questionnaire. Each week during the course of instruction, students were asked to evaluate the following using a 9-point scale that included descriptions of low, middle, and high scale-points:

a. Instructional Interest

1 = Boring

5 = Passable

9 = Absorbing

b. Informativeness of Instruction

1 = Unacceptable

5 = Beneficial

9 = Exceptional

c. Self-rating of Performance

1 = Poor

5 = Acceptable

9 = Outstanding

d. Instructor's Performance

1 = Poor

5 = Acceptable

9 = Outstanding

The mean ratings of each of the instructional groups for each of the four items are shown in Figure 4. All mean ratings were at least one scale value above the midpoint of the scale, indicating a relatively positive attitude on all four aspects of instruction included in the questionnaire. Further, the magnitude of the differences between means of the instructional groups making the lowest and highest ratings was less than one scale value in all comparisons.

Except for the ratings given for instructional interest, ratings made by students who received Air Force Instruction and Traditional Instruction were virtually the same, while students who received Augmented Air Force Instruction expressed a slightly more positive attitude. Ratings of instructional interest were quite similar for the three groups, with a slight favoring of Augmented Air Force Instruction in comparison with Control and with Air Force Instruction.

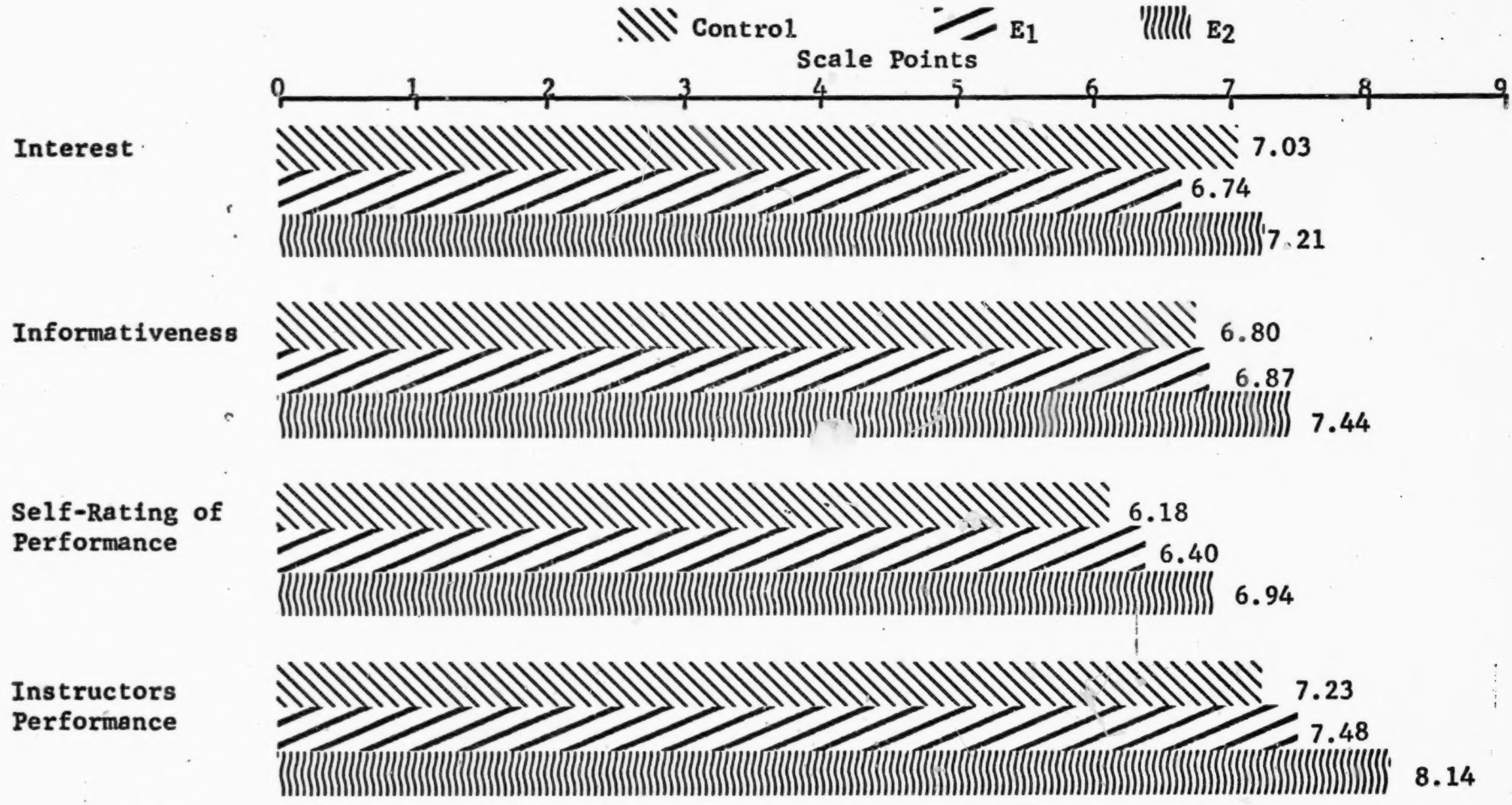

Figure 4. Mean weekly rating of instructional interest, informativeness of instruction, self-rating of performance, and instructor's performance by students in three instructional groups.

Class Attendance

Absenteeism was minimal and the same for students in all three instructional groups. Absenteeism was 1.1% among students receiving Traditional Instruction, 1.2% among students receiving Air Force Instruction, and 1.0% among students receiving Augmented Air Force Instruction.

Terminal Questionnaire

Inspection of the terminal questionnaire data indicates that few definite conclusions are warranted. Although students ranging from high school age to students enrolled in a four year college were involved, no distinction in age groups is available for evaluation purposes. Not all students completed the questionnaire and not all questions were routinely answered by the students who did respond. For the most part, the data is based on 72 students who had received Traditional Instruction, 81 who received Air Force Instruction, and 46 who received Augmented Air Force Instruction. Responses to selected categories on some of the questions are shown in Table 14.

At least three-fourths of the students in each of the groups used either completely or good to describe the extent to which the course they took satisfied their reasons for taking it. Of the three groups, the Air Force Instruction group was less well satisfied than the other groups. This group included high school students; the Augmented Air Force Instruction group did not. Only two-thirds of the students assigned to Air Force Instruction took the course for purposes of occupational training, while over 80% of those assigned to Traditional and Augmented Air Force Instruction had taken it for this reason. This difference is another possible reason for the discrepancy in many of the ratings.

Some confusion about objectives was evident. Some 27% of the Air Force Instruction group was unsure whether overall course objectives had been stated, and an additional 10% said they had not been stated. Approximately 15% of the students in the other groups were unsure about the statement of overall objectives, while 7% in each of these groups said they had not been stated. Nearly half of the students in the Traditional Instruction group thought objectives for only some of the units had been stated, while 40% and 33% respectively, of the Traditional and Augmented Air Force groups had the same opinion.

These results are tempered by evidence that some questions pertinent to this data must have been ambiguously worded. For example, the Air Force instruction, with or without augmentation, obviously was based on specified performance objectives; conventional instruction obviously was not. Thus, the negative responses of the students, as indicated above, became questionable. Utah instructors who taught Air Force Instruction groups during the test have assessed the situation as follows: In the traditional course, instructors verbally explained course goals and unit goals. However, when working with Air Force material, where objectives appeared in print, Utah instructors (in keeping with Air Force experience) did not consider it necessary to state the objectives verbally. Yet, the questionnaire specifically used the work "stated" relative to the communication of course and unit objectives. Further, the major source of printed objectives in the Air Force material being used, the TVI guides, covered them in a Summary section, usually without identification as "objectives" per se.

Relative to the other groups, a notably higher proportion of students who received Air Force Instruction thought there were too few tests, that they learned very little from the tests, and that the lectures and discussions were seldom interesting. This data also is questionable, inasmuch as the Air Force course segment used, as noted, called for minimum lecture/discussion, and was predominantly film-based. One explanation of the data would be that the films used contained more "lecturing" in their own right than was to the liking of the students.

A greater proportion of students in the Air Force Instruction group also felt that more course work was assigned than needed, less laboratory time was provided than needed, the course proceeded too rapidly, and the laboratory facilities and equipment were more than adequate.

On questions applicable only to those students who received Air Force Instruction, the students who received straight Air Force Instruction were considerably more negative than students who received Augmented Air Force Instruction. A little over one-fourth said the films were seldom interesting compared with only 13% of the Augmented Air Force Instruction group. Workbooks were seldom interesting according to 16%. These students were also disproportionately negative about the slides.

TABLE 14

RESPONSES OF STUDENTS IN THREE INSTRUCTIONAL SELECTED CATEGORIES FOR SOME ITEMS OF THE TERMINAL QUESTIONNAIRE FOR THE ELECTRONICS COURSES

	Traditional Instruction	Air Force Instruction	Augmented Air Force Instruction
Reason for Taking Course Satisfied			
Completely	31%	17%	41%
Good	57%	60%	50%
Fair	11%	20%	9%
Poor	-	3%	-
Overall Course Objectives Stated			
No	7%	10%	7%
Unsure	15%	27%	13%
Objectives for Every Unit Stated			
Some Only	49%	40%	33%
No	1%	6%	-
Number of Tests			
Too few	10%	42%	20%
Learning from Tests			
Very little	8%	28%	11%
Time Required for Home Exercises			
More than other courses	34%	31%	50%
Assigned Course Work			
More than needed	10%	18%	11%
Less than needed	7%	6%	4%
Pacing of Course			
Too fast	22%	31%	15%
Too slow	17%	12%	13%
Laboratory Time			
More than needed	11%	11%	24%
Less than needed	22%	30%	9%
Laboratory Facilities and Equipment			
More than adequate	21%	34%	20%
Less than adequate	13%	9%	4%

TABLE 14 (continued)

	Traditional Instruction	Air Force Instruction	Augmented Air Force Instruction
Lectures and Discussions			
Seldom interesting	1.4%	18%	2%
Laboratory Exercises			
Seldom interesting	13%	8%	6%
Films			
Seldom interesting	-	27%	13%
Workbooks			
Seldom interesting	-	16%	2%
Slides			
Seldom interesting	-	50%	18%
Slides			
Seldom useful	-	47%	4%
Slides			
Seldom easy to understand	-	32%	-

Follow-up Questionnaire

An attempt was made to assess student interest with a questionnaire seeking comparative response to the DC circuits course relative to the AC circuits course which immediately followed it for all project students, and which was presented in the traditional manner.

However, nearly half the students did not answer the follow-up questionnaire, and the potential bias resulting from the attrition would make it dangerous to draw conclusions from the response.

B. Aircraft Mechanics

Performance of two groups of students on the pre-test and on two post-tests was compared. (See Table 15.) Both groups received Traditional Instruction during the first and final portions of the aircraft mechanics course. One group (Air Force Instruction) received five weeks of instruction based on the Air Force Instructional system midway in the course, while the other group (Traditional Instruction) continued in the regular course, receiving about the same subject matter in the traditional manner.

Pre-test Results

An initial performance test was administered immediately prior to the separation of the Air Force Instruction and Traditional Instruction groups. Within each group, half took Form A of the test; half took Form B.

The groups did not differ on the Pre-test. The mean score for the 22 students assigned to Air Force Instruction was 37.8 (S.D. = 7.52), while the mean score for the 21 students assigned to Traditional Instruction was 34.7 (S.D. = 8.84). t for the 3.1 difference between means was 1.23 (df = 41), which is not significant at the 5% level of confidence.

Post-test I Results

For Post-test I, which was administered at the end of the 5-week unit of instruction, each student took the alternate of the test form taken for the Initial Test.

Performance of the students who received Air Force Instruction was higher than the performance of students who received Traditional Instruction. The mean scores of the two groups were 59.3 (S.D. = 6.96) and 52.9 (S.D. = 8.42), respectively. The difference between means was 6.4; t was 2.59 (df = 39), which is significant at the 5% level of confidence. Two of the students receiving Traditional Instruction were not available for Post-test I.

Post-test II Results

Approximately four months after termination of instruction, the students were given the same form of the test they had taken for Post-test I. Two students in the Air Force Instruction group and six students in the Traditional Instruction group were no longer available for testing at this time.

Performance of the two groups on Post-test II did not differ. The mean score for the 20 students who received Air Force Instruction was 51.7 (S.D. = 9.19), while the mean score for the 15 students who received Traditional Instruction was 49.0 (S.D. = 8.56). t for the difference between means of 2.7 was 0.88 (df = 33), which is not significant at the 5% level of confidence. For both groups, the obtained means were lower on Post-test II than on Post-test I, a finding that seems to suggest some loss of proficiency with time. The research design did not permit a statistical test of within-group means to determine whether these differences were likely to be real or merely due to chance.

The results of this part of the study must be qualified. In the first place, students were not assigned at random to the two instructional groups due to irreconcilable scheduling difficulties. Second, test Forms A and B were not equivalent as shown by data from the Pre-test, taken prior to the introduction of instructional differences.

Twenty students took Form A, eight of whom were assigned to Traditional Instruction while 12 were assigned to Air Force Instruction. The mean scores for these 20 students was 39.70 (S.D. = 6.21). Twenty-three students took Form B; 13 were assigned to Traditional Instruction, while 10 were assigned to Air Force Instruction. The mean score for these 23 students was 33.30 (S.D. = 9.20). t for the difference between means of 6.40 was 2.44 (df = 41), which is significant at the 5% level of confidence. The distribution of students in Traditional Instruction and Air Force Instruction groups taking Forms A and B of the test are shown in Table 17.

The mean Initial Test score for students assigned to Traditional Instruction is probably underestimated because of the larger proportion of students taking Form B of the test (13 out of 21), whereas the mean Initial Test Score for students assigned to Air Force Instruction may be slightly overestimated due to the larger proportion of students in this group who took Form A of the test (12 out of 22).

On Post-tests I and II, the reverse is true, since each student took the form alternate to the one taken on the Initial Test. Attrition within the instructional groups also affected the proportion of students taking each of the test forms. Thus, on Post-test I, 11 out of 19 students who received Traditional Instruction took Form A compared with 10 out of 22 students who received Air Force Instruction. Even so, the difference between means was significant as discussed previously, though the mean score of students who received Air Force Instruction was undoubtedly underestimated. The effect of Air Force Instruction is clearly superior as judged by test scores.

While the two instructional groups did not differ on Post-test II, it is possible that differences were obscured by the lower scores produced by Form B of the test. While eight of the 15 students who received Traditional Instruction took Form A, only eight of the 20 students who received Air Force Instruction took Form A. Therefore, the mean score of the latter group may have been depressed due to the disproportionate number of students taking Form B. Further, the variance of Post-test II scores from Form A differs significantly from Post-test II scores from Form B. F (single tailed) was 75.69 (df = 11 & 7), obviously significant beyond the 1% level of confidence.

Gain Scores

Gain scores were computed by the same formula as noted previously. The mean gain score of students who received Air Force Instruction was 28.2, while the mean for students who received the standard instruction was 22.4. These means do not differ significantly (see Table 17), suggesting that improvement in performance between the beginning and end of the treatment period was virtually the same for both groups. The effect, if any, of the two test forms on gain scores could not be determined.

TABLE 15

INITIAL, POST-TEST I AND II PERFORMANCE OF TWO GROUPS RECEIVING INSTRUCTION IN AIRCRAFT MECHANICS

	Traditional Instruction		Air Force Instruction
Initial Test			
Mean	34.7		37.8
S.D.	8.84		7.52
N	21		22
D		3.1	
t		1.23	
df		41	
Post-test I			
Mean	52.9		59.3
S.D.	8.42		6.96
N	19		22
D		6.4	
t		2.59*	
df		39	
Post-test II			
Mean	49.0		51.7
S.D.	8.56		9.19
N	15		20
D		2.7	
t		0.88	
df		33	

* $p < .05$

TABLE 16

MEANS, S.D's AND NUMBER OF STUDENTS IN EACH OF THE INSTRUCTIONAL GROUPS TAKING FORM A AND FORM B OF THE AIRCRAFT MECHANICS TEST

	Traditional Instruction		Air Force Instruction	
	Form A	Form B	Form A	Form B
Initial Test				
Mean	38.5	32.3	40.5	34.6
S.D.	5.7	9.6	6.4	8.0
N	8	13	12	10
Post-test I				
Mean	55.5	49.4	59.1	59.5
S.D.	8.2	7.8	4.2	8.9
N	11	8	10	12
Post-test II				
Mean	51.4	47.1	51.1	52.2
S.D.	9.7	7.7	1.0	8.7
N	8	7	8	12

TABLE 17

GAIN SCORE COMPARISON OF TWO GROUPS RECEIVING INSTRUCTION IN AIRCRAFT MECHANICS.

	Treatment Condition	
	C Traditional Instruction	E Air Force Instruction
Mean	22.4	28.2
S.D.	11.3	9.7
N	19	21
t	1.70*	
df	38	

* $p > .05$

Terminal Questionnaire

At the time instruction was terminated, students in the aircraft mechanics course completed a questionnaire about the course. The questionnaire was similar to the one described in the section on electronics. Four rating categories were used for each of the aspects of the course covered in the questionnaire. Aspects such as interest level, usefulness, clarity, and so forth were qualified, for the most part, by descriptive terms such as *always*, *nearly always*, *usually* or *normally*, and *seldom*.

Due to the small number of students in both the Traditional and Air Force Instruction groups, comparisons of ratings are tenuous. While the results do indicate the opinions of the students in these two groups, the extent to which the results may be generalized to other students is open to question.

Ratings on any question could be distributed over four categories. The number of students in each of the instructional groups was so small -- 19 in Traditional and 21 in Air Force Instruction -- that percentages are apt to be misleading, but the elaborate procedures for statistical tests under these conditions did not seem warranted. Therefore, the results that follow are suggestive only and do not necessarily represent significant differences or trends. Only those items deemed to have the greatest import have been included. Responses in selected categories to some of the questions are shown in Table 18.

Both groups of students seemed well satisfied with their courses as shown by their responses to the question, "How well did the course satisfy your reason for taking it?" Ninety per cent of the students who received Traditional Instruction gave ratings of either *completely* or *good* to this aspect of the course; 86% of the students who received Air Force Instruction used these categories. In both groups, the majority rating was *good* rather than *completely*. None gave a rating of *poor*. Only one student in the entire study population took the course for reasons other than occupational training.

Some students in both groups seemed confused about objectives; a few in each group were unsure whether objectives for the overall course had been stated. Nearly two-thirds of the students who had Air Force Instruction said objectives were stated for some but not all instructional units, while a little less than half of the students who had Traditional Instruction made the same judgment.

(Again, as with the Terminal Questionnaire for the electronics courses, the word "stated" in relation to the communication of objectives can be considered to be ambiguous, making it dangerous to draw conclusions from these responses).

A few students in both groups felt too few tests had been given; none complained of too many tests. A small number in each group also thought the amount of course work assigned was less than the amount needed to learn the material. Students in both groups expressed a positive attitude toward the demonstrations provided. They also regarded the homework, both required and optional, positively.

Some of the students who received Air Force instruction felt too little lab time was given and that the laboratory facilities and equipment were poor. Some also thought the homework required more time than for most other courese and that they learned very little from the tests.

These students completed some questions about programmed instruction and workbooks that were not applicable to the traditional course. The majority rated programmed instruction as nearly always interesting, useful, or easy to understand as opposed to always or normally or usually so. Reactions to the workbook were also positive, though interest level was less highly regarded than the workbook's usefulness or clarity.

Class Attendance

Absenteeism was higher among the students receiving Air Force Instruction than among students receiving Traditional Instruction.

Instructor Comments

According to Battelle staff members, data from the Instructor Comment Sheets and several conversations indicate that both instructors liked the instructional materials available for the Air Force program. The Control group instructor did not respond favorably initially to the Air Force Instructional system. After the completion of the experiment, however, both instructors endorsed the Air Force Instructional system because of the overall system design and especially because of the excellence of the materials for student and instructor use. In addition, they reported the Air Force system allows the instructor to cover more material in less time, allows students to learn more on their own and rely less on the instructor, and would permit restructuring the existing distribution of classroom and laboratory time.

TABLE 18

RESPONSES OF STUDENTS IN TRADITIONAL AND AIR FORCE INSTRUCTION GROUPS IN SELECTED CATEGORIES TO SOME ITEMS OF THE TERMINAL QUESTIONNAIRE FOR THE AIRCRAFT MECHANICS COURSE

	Traditional Instruction (N=19)	Air Force Instruction (N=21)
Objectives for Overall Course Stated		
Yes	74%	76%
Unsure	26%	24%
Objectives for Every Unit Stated		
Yes	58%	38%
Some units only	42%	62%
Too Few Tests	26%	14%
Learning from Tests		
Great deal	47%	24%
Very little	-	14%
Time for Homework		
More than for other courses	11%	33%
Less than for other courses	32%	-
Assigned Course Work		
Less than needed	16%	10%
Pace of Course Too Slow	16%	-
Lab Time		
More than needed	42%	-
Less than needed	37%	43%
Lab Facilities and Equipment		
Less than adequate	-	38%

C. Nurse's Aid Course

The experimental portion of the nurse's aid course occurred as the middle segment of the course and consisted of 31.5 hours of instruction that covered the following areas: lifting and moving patients, sterile equipment and supplies, surgical aseptic techniques, common disease-causing organisms, medical aseptic techniques, comfort and hygiene, diets, and medical terms. Data was available for nine students who received Traditional Instruction, six students assigned to unmodified Air Force Instruction, and five students assigned to Modified Air Force Instruction. The revision of the Air Force program consisted only of a change of terms in the programmed text from military to civilian language. The two groups assigned to Air Force Instruction attended the same class. Because of small N's, and because modification was so minor, data from these two groups have been combined in the following analysis of results.

At the beginning of instruction, students took tests over each of the areas included in the experimental portion of the course. An alternate form of the test was administered at the termination of instruction. A follow-up test was also given; however, test results for only four students in the Air Force group were available, so the results could not be analyzed. Test scores were reported as the percentage of correct responses.

Initial Test Results

On the Initial test, the performance of the two groups differed significantly in five of the eight areas tested: lifting and moving patients, common disease-causing organisms, medical aseptic techniques, diets, and medical terms. These comparisons are shown in Table 19. The mean score of students assigned to Traditional Instruction was higher in each of these areas.

Post-test I Results

At the termination of instruction, the two groups differed in only two of the areas. On the medical aseptic techniques unit, the mean score of students who received Traditional Instruction was significantly higher than the mean score of students who received Air Force Instruction. Traditional Instruction appears to have been unusually successful in the area of sterile equipment and supplies, as all students in that instructional group achieved 100% correct on the Post-test, while students in the Air Force Instruction group achieved a mean score of only 81.82% (S.D. = 25.11). The scores from this test suggest that it measures discrete intervals rather than along a continuum, as only certain scores appeared, for example, 100%, 83%, 67%, etc.

The effect of instruction on the change in student performance within each instructional group was also examined. The criterion measure for change was the difference between the percentage of correct responses on the Post-test and the Initial Test. These comparisons are shown in Table 20.

Air Force Instruction produced significant change in more areas than did Traditional Instruction. The performance of students assigned to Air Force Instruction changed significantly in six of eight areas, while change was significant in only four of the eight areas for the students who received Traditional Instruction. Change in the areas of common disease-causing organisms, diets, and medical terms was significant for both groups. Only those students who received Traditional Instruction showed significant change in the area of sterile equipment and supplies. The areas in which change was significant for only those students who received Air Force Instruction were lifting and moving patients, surgical aseptic techniques, and comfort and hygiene.

Even though change scores were significant for a number of areas when examined for each group separately, between-group comparisons of the magnitude of change showed significant differences in only two of the six areas, common disease-causing organisms and medical terms excluded. The amount of change was significantly greater for students in the area of comfort and hygiene who received Air Force Instruction. The amount of change in test scores of students who received Traditional Instruction on this unit was less than would be expected from intrinsic measurement error.

The magnitude of change was significantly greater for students who received Traditional Instruction in the area of sterile equipment and supplies. This result needs to be qualified, however, by the failure of the test to provide a continuous scale.

Though change was significant in both groups on common disease-producing organisms, the variances of the change scores differed significantly. F (single-tailed) was 9.550 and with df = 10 and 8 has a probability of less than 1%.

Change also was significant for both groups on medical terms. Here again difference between variances of the change scores was extreme. F (single tailed) was 12.55 (df = 10 & 8), a probability of less than 1%. While scores of two groups on the Post-test for the unit on common disease-producing organisms were identical: 78.22% for the Traditional and 78.64% for the Air Force Instruction, the Post-test scores on medical terms were lower for the Air Force Instruction Group than for the Traditional Instruction Group if the difference is taken at face value. (Statistically the mean scores did not differ because of the large variance of the scores.) The Air Force Group began instruction with a mean score of only 26% correct compared with a mean score of 76% correct for the Traditional Instructional Group. At the termination of instruction the Air Force Group had achieved a performance about equivalent to the initial performance of the Traditional Instructional Group at the beginning of instruction.

Thus for both of these units -- common disease-producing organisms and medical terms -- the Air Force Instruction was apparently unusually effective for some students and ineffective for others.

Gain Scores

Gain scores were computed according to the established formula, as noted, for score differences between Pre- and Post-test, for each of the three groups. (See Table 21). Tests of significance showed no difference in overall gain between any pair of groups, indicating that significant gains obtained for individual units of the course were overshadowed when all units are considered jointly.

TABLE 19

COMPARISON OF INITIAL AND POST-TEST RESULTS OF TRADITIONAL (N = 9) AND AIR FORCE (N = 11) INSTRUCTIONAL GROUPS FOR THE EXPERIMENTAL PORTION OF THE NURSE'S AIDE COURSE

Instruction	Initial Test					Post-test				
	M	S.D.	D	t	p*	M	S.D.	D	t	p
Lifting and Moving Patients										
Traditional	77.00	11.31	23.45	2.37	.05	83.89	14.15	20.44	1.90	
Air Force	53.55	26.29				63.45	27.89			
Sterile Equipment and Supplies										
Traditional	57.22	19.37	10.87	0.98		100.00	0	11.06	-	
Air Force	68.09	26.15				81.82	25.11			
Surgical Aseptic Techniques										
Traditional	70.22	28.00	0.96	0.79		90.56	8.40	2.83	0.63	
Air Force	71.18	23.72				87.73	10.27			
Common Disease Causing Organisms										
Traditional	52.67	9.14	12.49	2.33	.05	78.22	9.01	0.42	0.67	
Air Force	40.18	13.62				78.64	15.87			

* $\underline{t}_{.05}$ (df = 18) = 2.101; $\underline{t}_{.01}$ (df = 18) = 2.878

TABLE 19 (continued)

Instruction	Initial Test					Post-test				
	M	S.D.	D	t	p*	M	S.D.	D	t	p
Medical Aseptic Techniques										
Traditional	75.11	11.68	13.20	2.51	.05	87.56	9.22	16.01	2.59	.05
Air Force	61.91	10.48				71.55	15.50			
Comfort and Hygiene										
Traditional	77.66	15.70	14.88	1.84		78.33	8.31	0.69	0.11	
Air Force	63.18	18.06				77.64	16.95			
Diets										
Traditional	68.11	6.95	17.93	3.98	.01	81.44	6.52	7.80	1.16	
Air Force	50.18	11.22				73.64	18.20			
Medical Terms										
Traditional	76.22	17.35	50.31	5.99	.01	87.44	14.96	13.53	1.20	
Air Force	25.91	18.06				73.91	28.36			

*$t_{.05}$ (df = 18) = 2.101; $t_{.01}$ (df = 18) = 2.878

TABLE 20 COMPARISON OF WITHIN-IN GROUPS AND BETWEEN GROUPS CHANGE (IMPROVEMENT) SCORES OF TRADITIONAL AND AIR FORCE INSTRUCTIONAL GROUPS

Instruction	M	S.D.	df	t	p*	D	df	t	p**
Lifting and Moving Patients									
Traditional	6.89	18.16	8	1.07		-3.02	18	0.42	
Air Force	9.91	12.54	10	2.50	.05				
Sterile Equipment and Supplies									
Traditional	42.78	19.36	8	6.24	.01	29.05	18	2.12	.05
Air Force	13.73	34.84	10	1.25					
Surgical Aseptic Techniques									
Traditional	20.33	30.19	8	1.90		3.78	18	0.98	
Air Force	16.55	22.59	10	2.32	.05				
Common Disease Causing Organisms									
Traditional	25.56	8.14	8	8.88	.01	-12.89	18	-***	
Air Force	38.45	25.15	10	4.84	..01				

*df=10, t.05 = 2.228, t .01=3.169, df=8, t.05=2.306, t.01=3.355

**df=18, t.05 = 2.101; t .01=2.878

***F (single-tailed) = 9.550, df=10/8, p< .01, t not computed

****F (single-tailed) = 12.52, df =10/8, p < .01, t not computed

TABLE 20 (continued)

Instruction	M	S.D.	df	t	p*	D	df	t	p**
Medical Aseptic Techniques									
Traditional	12.44	16.95	8	0.66		2.80	18	0.32	
Air Force	9.64	19.65	10	1.55					
Comfort and Hygiene									
Traditional	0.67	8.74	8	0.217		-13.79	18	2.69	.05
Air Force	14.46	12.23	10	3.74	.01				
Diets									
Traditional	13.33	8.77	8	4.30	.01	-10.12	18	1.43	
Air Force	23.45	18.55	10	4.00	.01				
Medical Terms									
Traditional	11.22	9.40	8	3.37	.01	-36.78		-****	
Air Force	48.00	33.28	10	4.56	.01				

* df=10, t .05=2.228, t .01=3.169, df=8, t .05=2.306, t .01=3.355

** df=18, t .05=2.101; t .01=2.878

*** F (single-tailed) =9.550, df=10/8, $p < .01$, t not computed

**** F (single-tailed) =12.52, df=10/8, $p < .01$, t not computed

TABLE 21

GAIN SCORE COMPARISON FOR THREE GROUPS RECEIVING NURSE'S AIDE INSTRUCTION

	Treatment Condition					
	C Traditional Instruction		E_1 Air Force Instruction		E_2 Modified Air Force Instruction	
Mean	49.4		48.9		46.4	
S.D.	37.5		39.4		34.9	
N#	63		42		35	
t		.06		.29		.41*
df		96		75		103

# subtests X students

* comparison of Groups C and E_2

X. DISCUSSION

The importance of the instructor cannot be overemphasized in any discussion of the results of this study even though its purpose was to assess the feasibility of using Air Force materials in the civilian classroom.

In fact, in subject areas as detailed as electronics or as critical as nursing, the subject matter competence of the instructor must be judged to be an important ingredient.

As previously mentioned, the role of the instructor in the experimental groups differed from that of a conventional instructor. The experimental group instructor did not carry the major burden of information presentation through the lecture. Instead, he was the manager of instruction, making sure that materials and facilities were available when needed, and a consultant, helping students with answers to questions and assisting them in other ways, as needed.

There can be no doubt that the instructor had an important influence on the competence and the attitude of the Experimental Group students, but it is impossible to gauge the extent of that influence.

Electronics

The electronics data provide the broadest base for interpretation. Unlike the Nurse's Aide and Aircraft Mechanics courses which had small numbers of students participating at only one school each, there were more than 200 students participating at five schools for the electronics portion of the study.

In general the results show that the students of the Experimental Groups (using Air Force techniques and materials) benefited significantly more from their instruction than did the students of the Control Groups. Both Experimental Groups scored significantly higher on Post-test I than did the Control Group, though conclusions regarding the Augmented Air Force group must be considered somewhat tenuous. This group scored significantly higher than the other two groups on the Pre-test, probably because of the significantly higher number of students in that group who had an electronic hobby. Thus, the most that can safely be inferred from the fact this group scored higher on Post-test I than did the Control Group is that an initial difference was not obscured by the instruction.

Gain score comparisons illuminate the distance traveled by the various groups between Pre-test and Post-test times. In this instance, both Experimental Groups had gain scores higher than that of the Control Group at a significance beyond the 1% level of confidence. This would suggest that the instruction of the Experimental Groups was noticeably more potent.

A point must be made about the "fit" of both the Traditional and Air Force courses to the students' entering skills. Since a significant number of incoming students had taken previous courses or had hobbies in electronics, one would suspect that they did not enter the course with zero information. This is confirmed by the relatively high Pre-test scores in all groups. When students enter a course in various degrees of under-preparation, the typical response is to provide remedial instruction. When students enter a course with various degrees of over-preparation, as here, no remedial action is typically taken, either to student or course. The classic instructional attitude is, "It won't hurt them to go over it again." In fact, both the efficiency of the course and the motivation of the student could reasonably be expected to improve if more credit were given for a student's entering skills, permitting him to start at a point appropriate to his needs.

The attitudes of students in all three electronics groups appeared to be relatively positive. On questions of interest, informativeness, and opinions about their own and their instructor's performance, differences varied less than one scale value on a scale of nine points. Absenteeism was comparable across all groups, and students reported being generally satisfied with their instruction, be it traditional or experimental.

Nonetheless, students of the Air Force Instruction Group appeared to be generally less satisfied on some items relating to course operation. They felt, for example, that they had too few tests, and that lectures, discussion and laboratory work were less interesting than indicated by the other groups. (As noted, this student reaction to "lectures and discussion" is open to question inasmuch as the Air Force course minimizes both). They rated the films and workbooks as seldom interesting, and particularly scored the slides as lacking in interest. The complaints of this group may relate to the effects of massed and spaced practice. The Augmented Group received segments of Traditional Instruction between segments of Air Force Instruction, during a period forty hours longer than for the other Air Force group. Nevertheless, the attitudes of all groups was on the positive side of neutral.

Project instructors were more enthusiastic in their feelings about the Air Force materials. One electronics instructor, for example, went so far as to conclude his report of the study with the following comment:

> "The subjective conclusions of the instructors involved were very positive in relation to the original question of the research ... A consensus of opinion existed among all who were closely connected with the project from its beginning to its conclusion, that it was a big success and that many more Air Force materials, on most all other subjects, could be used most advantageously by properly oriented civilian schools on the technical level."

Aircraft Mechanics

Though there was no difference when the two groups (of 21 and 22 students each) began this course, Post-test I scores for the Experimental Group was higher than that of the Control Group, at the 5% level of confidence. This confidence must be badly shaken, however, by the lapses in experimental rigor associated with this part of the study. The non-equivalence of the test forms is enough to invalidate most conclusions, even though that non-equivalence undoubtedly acted to inflate the Control Group scores and depress those for the Experimental Group. Further, many items on those tests were found to be ailing -- some were not related to the objectives they were supposed to assess, some had no correct answers, some had two correct answers, some were unclear, and some had other problems. Worse, there were different numbers of troublesome items on the two different forms. (Though it is known that the electronics tests also had some weak or inappropriate items, their number is not considered large enough to weaken the conclusions drawn from the results.)

There were other problems. Test equipment was limited, and many units of equipment prescribed for the Air Force course were unavailable; significantly more Control students had a relevant hobby than did the others. About all that can be said is that even in the face of these obstacles the instructors and the materials associated with the Experimental Group appeared to hold their own with the Control Group. Because of the direction of bias of the non-equivalent tests, it is highly likely that the Experimental Group would show up better in future studies using better instruments of measurement.

Here again, the attitudes of both groups appeared equivalent. Both groups seemed well satisfied with the type of instruction they received. The response of the two groups to one item was different enough to warrant mention, however. The Control Group said they learned a great deal from the tests, while the Experimental Group said they did not learn a great deal from the tests, a result that speaks in favor of the Air Force Instruction. Students have no business learning a lot from tests. The purpose of testing is to assess what is already known. If a student learns a great deal from a test it is likely it was not made clear to him just what he was supposed to learn before he took the test, or that the instruction was not as effective as it might have been.

Nurse's Aide

Again, data from this portion of the study is rather difficult to interpret because of intruding factors (most of which related to student selection) not under the control of the investigators. Students of the Experimental Group, it will be recalled, had a lesser degree of educational background. Its members included no high school graduates, while Control Group members all had high school degrees or the equivalent and a few had had a year of college study. And there was a marked social imbalance: the Control Group, all housewives, presumably took the course as an avocation, with some degree of public service as a motivation; the Experimental Group, with no housewives and all but one a welfare case, presumably took the course out of necessity. Moreover, the two groups differed widely in their initial performance level, the Control Group scoring significantly higher in five of the eight subject areas.

At the termination of instruction there was a difference in favor of the Control Group in only two subject areas. During instruction, the Experimental Group improved significantly in six of the eight subject areas, while the Control Group improved in only four of those eight areas. Under the circumstances, it is surprising that the Experimental Group performed as well as it did. (Several months after completion of the project, contact was made with hospitals employing project course graduates as Nurse's Aides. Reports from these hospitals indicated that former students in the Experimental Group are adequately performing assigned tasks, and at least as well as former students in the Control Group.)

One must conclude that even students who are relatively poor in academic background appear to be able to benefit significantly from the Air Force course.

* * *

This study was designed to put to a practical test the question of whether Air Force Instructional materials can be used effectively within the civilian educational system. It is time, therefore, to consider specifically those questions for which answers were sought, and which were introduced early in this report.

Does the proficiency yield of the Air Force courses meet the requirements for civilian schools such as those represented by Utah?

Unless the experimental courses prove to be effective enough to warrant their use, there is little reason to be concerned with feasibility issues such as modification costs and facilities required.

Comparisons of Pre- and Post-test data show that for electronics the groups receiving the experimental treatment (Air Force courses) performed significantly better than the Control Groups receiving Traditional Instruction. Both Air Force groups performed better than the Control Group, the Augmented Air Force Group at the 5% level of confidence and the Air Force Group at the 1% level of confidence. For the Aircraft Mechanics course, the Experimental Group was again higher on the Post-test I score than the Control Group, at the 5% level of confidence. Though these results must be considered questionable for reasons already discussed, the direction of the difference was in the favor of the Experimental Group. For the Nurse's Aide course there was again a difference in favor of the Experimental Group in that the improvement of the Experimental Group was significant in six of the eight subject areas; whereas improvement for the Control Group was significant in only four of the eight areas.

Gain scores also show the Experimental Groups in electronics superior to the Traditional Group. Although a Post-test score indicates the general level of student competence at the end of instruction, it does not take into consideration the level of competence that may have been present at the beginning of instruction. And although a t test will suggest the statistical significance of the difference between Pre- and Post-test scores, it does not reveal the actual extent of those differences. It is interesting to know that after instruction a group of students could perform significantly better than they could before the instruction, but it is also important to consider comparisons of actual change achieved by the groups.

As seen in Table 11, the mean gain scores for the electronics Experimental Groups were significantly greater than for the Control Group, suggesting that the former groups learned more during the instructional period than did the Control Group.

The gain score for the Augmented Air Force Instruction Group (57.5) was higher than that for the Air Force Instruction Group (53.9) in electronics, but this difference was not significant. Thus, even though the Augmented group included significantly more students with an electronics hobby, this group did not gain significantly more in performance than did the non-augmented group (E_1). Put differently, the instruction received by the group receiving the regular Air Force Instruction was sufficiently effective to cause students of that group to improve just as much as the group receiving the augmented instruction.

Though Post-test II was administered approximately three months after Post-test I, in the electronics course, these data are difficult to interpret. For one thing, students received varying amounts of instruction in AC electronics between administration of the two tests. The effect of this variable treatment is unknown. For another, Post-test II was administered to some students under unknown conditions. For a third, several students had dropped out of the program between administration of Post-test I and II; since it cannot be assumed that the dropouts constitute a random sampling of the students, it is possible that the group taking Post-test II is in some way systematically different from the group which took Post-test I.

From one point of view, the results must be considered less than satisfactory, however. It will be noted that the Post-test I scores were 65% for the Control Group and 71 and 76% for Experimental Groups 1 and 2 respectively. From the standpoint of what is possible to achieve with validated instruction, these are hardly impressive scores. One would expect that a course using validated materials would yield Post-test scores much closer to the maximum, especially when the Pre-test scores are so high. On the other hand, it is not unreasonable to assume that the scores of the Control Group represent satisfactory performance to the faculties of the participating schools. (Certainly there were no suggestions that the Control Group and its instruction differed in any important way from preceding classes.) Hence, one must conclude that the superior performance of the Experimental Groups, though depressed from what might be expected, genuinely represents an improvement over performance obtained from existing instruction.

It is therefore possible to conclude that the performance yield of the Air Force materials as used in this civilian setting is sufficiently high to warrant serious consideration of their use on a broader scale.

Do the objectives of the selected Air Force courses meet the objectives of civilian schools such as those of Utah?

As a preparatory step, this study called for Utah instructors to review the objectives of the Air Force courses. The intent was to compare Air Force objectives with Utah objectives to determine the extent of overlap. Instructors concluded that except for a need for more "depth" in mathematics and, at one school, for more laboratory time (both in electronics)that the fit was quite good and that the Air Force courses would meet their objectives.

During the course of the study, however, it became clear that Utah instructors had compared Air Force objectives with content items from their own lesson plans. Lacking specific performance objectives, (i.e., intended outcomes expressed in performance terms), they had compared lists of "what they taught" with statements describing what the Air Force course intended to achieve. It is impossible to tell specifically from this study, therefore, whether the Air Force objectives correspond to the objectives (or goals) of the Utah instructors. Only as far as scope and content are an indication of such correspondence can it be said that the Air Force and Utah courses "cover" similar items.

This experience prompts the following observations: Without knowing exactly what outcomes one hopes to achieve, it is difficult to make effective decisions about the various means of attaining those outcomes. It is possible that irrelevant test items will be tucked in among the relevant ones, leading to instruction that is more time consuming and less efficient than necessary, and evaluation that is somewhat misleading.

The problem with making decisions on the basis of statements about content is that it is virtually impossible to tell just what skills the student will have as a result of the instruction. The same content headings are associated with the training of an electronics maintenance man as with the training of a circuit designer, for example, but that content is treated differently and at different lengths for the two different skill outcomes. As an example, candidates for both maintenance and engineering work will study the subject of resistors, but the former will learn how to distinguish good from malfunctioning components while the latter will learn how to calculate which resistors will be most appropriate in a given circuit.

Clearly, if instructors and administrators are to make solid decisions about the appropriateness of Air Force courses in their own institutions, they must be able to compare their own intended outcomes with those of the Air Force courses; it therefore becomes imperative that they have their own objectives written down and stated in performance terms. Future use of Air Force materials in civilian schools will be improved in effectiveness to the degree that this documentation of civilian objectives is accomplished before initial selection of Air Force materials.

Do the Air Force requirements with regard to prerequisite behavior match those of schools such as those represented by Utah?

While the question of prerequisite matching springs readily to mind, it is misleading in view of the traditional definition of "prerequisite." Typically, prerequisites are stated in terms of course titles or instructor permission and in that sense a description of a prerequisite is more of an administrative tool than one that facilitates effective instructional decisions. It is of no value to know that a student has completed a given course unless one knows with some precision what skills he possesses as a result of that course.

The question might better be phrased: "Does the student entering the civilian course possess the skills that the Air Force Instruction presumes he has at this point?" Strictly speaking, one cannot answer this question either. Though the Air Force uses an ability test as part of its selection procedure, experimenters in this project were not provided with a list of entering behaviors expected of the incoming student. Similarly, Utah instructors did not have a list of entering behaviors assumed to be present in students entering their courses, and so a comparison of such lists was not possible. Utah instructors did, however, carefully review the Air Force materials and concluded that their students were likely to be as competent at the beginning of instruction as are the Air Force students.

If one asks whether Utah students did in fact benefit from the Air Force Instruction, an answer can be offered from the data. This data shows that students working with the Air Force materials learned significantly more than students of the Control Group, and it can be concluded that their entering condition was indeed one which enabled them to benefit from the instruction. This conclusion is strengthened by the knowledge that experimental students received no remedial instruction that might have acted to shore up deficiencies in the materials.

Are the instructional methods of the Air Force courses useable within a civilian system such as that of Utah?

The procedures required for effective use of the Air Force courses are somewhat different from those found in most classrooms. This was particularly true in the electronics materials used in this study. For one thing, the instructor is expected to give up his role as lecturer, since the major portion of the instruction is accomplished by film, videotape, or some other "packaged" medium. The instructor takes on a role of manager whose principal duties are guiding the instruction and assisting individual students. Additionally, students are given copies of the objectives so that they know precisely what they must do to demonstrate satisfactory performance. And again, instruction is expected to continue until a student has achieved satisfactory performance (unless a bad decision has been made with regard to the selection of one or more students).

A number of schools in the United States are now adopting such techniques from the first grade through the college level. Though teachers experience varying degrees of difficulty with the required shift in their activities, there is nothing about such procedures that makes them hostile to a civilian environment. There is no reason to believe that the methods associated with the Air Force materials either cannot be used or are not compatible with the existing structure of school systems such as those used in this study.

To what extent must Air Force materials be modified before they can be used within a civilian school system?

Obviously the answer to this question depends on the course under consideration. As seen in the present study, however, this proved to be a minor issue. The electronics course required no modification of the structure of the materials themselves. There was a requirement for a particular type of laboratory equipment, and videotapes had to be converted to motion picture film for the electronics course. However, during interviews following the course, Utah instructors reported that construction of the DC circuitry "breadboards" is a relatively simple matter and that it would be easier to construct new boards according to the Air Force specification than to modify those currently in use. The power supplies used in connection with the breadboards were commercially available kits, easily assembled by students with a minimum of experience in electronics.

Though breadboards and power supplies are required if the electronics course is to be taught according to Air Force specifications, it should be noted that these requirements involve equipment acquisition rather than modification of the instruction itself. The conversion to films was required only because the participating schools were not equipped with appropriate videotape playback equipment.

Modifications in the aircraft mechanics and nursing courses were minimal, the latter involving only a change from military terminology to civilian terminology, and this was done more to provide variation between groups than as a necessity. And, as noted, there was an equipment shortage in the aircraft mechanics course, as against the items prescribed by the Air Force.

What can be said about the cost effectiveness of adapting Air Force materials to civilian education?

The cost question advanced in the proposal for this project was more limited in scope. It asked: "How do modification costs, if any, compare with benefits derived from course use?"

While this specific question will be responded to, the larger issue of cost effectiveness, based on this project experience, also deserves attention here. And, if the cost effectiveness of adapting Air Force concepts, techniques and course materials to civilian education is to be weighed, it must be considered in its broadest context, with full regard for the "accountability" of our educational systems, both military and civilian.

Instructional modification of Air Force course materials, as reported, was minimal in this project, and therefore not significant as a cost factor; but equipment acquisition was involved and also must be considered as a cost issue.

The equipment cost factors surfaced by this project involve, in the electronics area, a DC circuitry "breadboard" (some 75 were constructed for the project) and motion picture film or videotape (about 30 hours in length) and a number of items in the aircraft maintenance area. Utah's civilian hospitals were the laboratories for the Nurse's Aide course, so equipment acquisition was not involved in that element of the project.

If electronic breadboards can be constructed by students (probably as a worthwhile learning experience), as proposed by Utah instructors, this no doubt could be accomplished within the financial means of most school systems. Heavy use of visual aids (slides, film, videotape) by the Air Force, as contrasted with conventional experience, at least in Utah, is something else again. Only three copies were made of each film used in the electronics course, and these were converted from videotape due to Utah's lack of video facilities. Thus, project experience does not contribute to realistic determination of cost in this area. Indeed, the unit cost for this film requirement would depend almost entirely on the volume involved. Slides and films of equal or better quality, covering basically the same subject areas, are known to be available at market prices, and this use of visual aids is not out of line with the national trend in civilian education. Further, more and more school systems are being equipped to use videotapes, which would lower costs even more if Air Force materials were adapted.

Equipment costs related to subject areas such as aircraft mechanics quite probably pose major barriers to civilian adaptation; and, as it has been noted, one Air Force course in aircraft maintenance was ruled out of the Utah study because of the cost required for equipment implementation. However, generalization is presumptuous short of a wide-scale assessment of minimum equipment requirements related to the use of Air Force materials.

In the Utah project, government surplus equipment sources (another area worthy of more investigation) produced only about one-third of the equipment prescribed by the Air Force for the course segment on aircraft mechanics. Thus, we do have evidence that at least equal results in student performance can be obtained with the use of substantially less equipment than prescribed by the Air Force. What the results might have been, had more or all of the prescribed equipment been available, is a matter of conjecture. At least we know that lack of equipment did not make this Air Force course less effective than the conventional course.

Beyond these immediate reactions, any sound assessment of the cost factor must be made against this background: Air Force instructional systems, including the course segments studied in the Utah project, are designed to meet specific job entry requirements within the Air Force. That these requirements are pertinent to civilian education is suggested by the knowledge that a great majority (some estimates: as high as 90%) of Air Force career categories involving vocational/technical skills have close job entry parallels in civilian life. Further, Air Force courses are changed, as rapidly as possible, when there is evidence that job entry requirements are not being met. This evidence appears in the form of repeated feed-back information to the "school system" (Air Training Command) from the "employer" (some 20 using commands). Air Training Command and the using Air Force commands operate under what is, in effect, a performance contracting system. Each contract equivalent, known as Training Standards, specifies the performance "level" to which graduates from Air Training Command must measure up. Performance levels, in each instance, are established jointly by training and using organizations. In essence, the Air Force "school system" is accountable to the "user."

No lavish claims are made herein for the Air Force training system. It shares the weaknesses common to education generally. No presumptions are intended to the effect that the Air Force has achieved true "accountability" of performance, since monetary gains and penalties obviously are not involved. No argument is advanced that the controlled conditions common to a military establishment can be replicated in civilian life. Nor is it projected that Air Force job entry performance requirements can become the basis for establishing civilian school curricula. The broader goals of civilian education, the additional options to which the civilian student must be exposed, all are recognized. But, in this project it seemed worthwhile to consider all aspects of Air Force training experience in the search to discover what, if anything, might be applicable to civilian education.

Against this background, project investigators sponsored a workshop for Utah project supervisors and teachers about midway in the experiment. This session helped advance the voluntary (and highly commendable) efforts of a group of these educators to update themselves on the application of performance objectives to classroom procedures. Further, and perhaps more important, the workshop helped generate a movement toward what might be considered an "accountability" concept within the Utah education system.

During the workshop, representatives from Ogden Air Materiel Area, largest employer in the state, confirmed the need for a repeated Air Force investment in basic education to bring Utah school graduates up to job entry qualifications.

Utah authorities moved quickly to fill the gap. Electronic specialists from Air Force, industry and the unions were called together with Utah educators for a two-week workshop. This was the first step toward development of an "articulated" curriculum in the electronics area. Educators worked with the "users" to develop more adequate requirements: for example, what did they want a graduate to know specifically about DC circuits, about AC circuits?

Industry specialists reviewed Air Force course outlines in these two subject areas, down to the sub-unit level, contributed to additions and subtractions in the outline.

This effort stimulated a request for the Air Force's AC circuits course, so that an AC/DC course package could be developed for standardized training on a state-wide basis. Materials for the AC course were made available by the Air Force, through the Aerospace Education Foundation, with the state of Utah financing the conversion of video tape (28 hours in length) into motion picture film. The AC/DC package is being tested in the Utah school system.

Interviews with representatives of three participating industries (Litton, Univac, Signetics) reveal the positive reaction of the "user." Utah's "articulated" curriculum, as projected, will provide Industry, for the first time, with standardized information on the performance criteria they can expect from the Utah school system, and Industry welcomes the prospects. All this is merely a step toward a school system becoming more "accountable" to the employers it serves and, in the long run, more accountable to its students. But it is a step forward, and it is pertinent to cost effectiveness.

When the Air Training Command "contracts" with a using Air Force command to deliver a graduate at a skill level acceptable to the "user", ATC operates on the basis that at least 90% of its graduates will be in this category. True, there has been significant selectivity in the student population, not generally matched in civilian education. But, when Air Force training is measured, cost effectively, this high production rate is a major factor.

When a two-year technical institute in Utah, or in most any state, delivers graduates to Industry -- those it feels will satisfy industrial requirements -- the technical institute knows from experience that only 25% of its graduates, at best, will be in this category.

Cost-wise, the difference in productivity -- 90% in the military, 25% in civilian life -- cannot be ignored in terms of the investment made by the taxpayer, up to that point, in the education of the individuals involved. Assuming that the civilian 25% move into jobs without further basic education, Industry's only recourse with the remaining 75% -- assuming jobs are waiting -- is to provide the basic, or more properly the remedial, education demanded.

When this occurs, as it does throughout the nation, a citizen is paying at least twice to get one education job accomplished -- once or more as a taxpayer, depending on his local and state tax structure for education, and again as a consumer in higher prices bolstered by these education costs. Cost effectiveness in education must be considered with such "hidden" costs in mind, however over-simplified this example might be.

If, as employers indicate, public school education geared more closely to job entry requirements can result in dollar savings to Industry, and therefore to taxpayers and consumers; and if, as this Utah project experience indicates, learning geared more closely to established performance objectives relates directly to job entry qualifications; and if, as evidence from the project indicates, the Air Force instructional system can help make the civilian system more accountable to industry, taxpayers, consumers -- and students ... on these terms we can begin to determine the true cost effectiveness of Air Force adaptations.

What can be said about the efficiency of the Air Force materials?

Efficiency is usually defined as the ratio of output to input. In the present instance, output figures are those of gain scores, since the output of concern is the degree of performance improvement of the students. It is extremely interesting to use instructional time as the measure of input or effort expended, and to compare the ratios of performance to time for the three electronics groups.

Using the ratio of gain scores to instructional hours for the three electronics groups as the basis for an efficiency index, the results can be seen in Figure 6. The efficiency of the Control Group was lowest (.35), the efficiency of the Augmented Air Force Group was next lowest (.48), and that of the Air Force Instruction Group was highest (.60). This index reflects the fact that the non-augmented group attained a proficiency significantly superior to that of the Control Group in approximately two-thirds the time.

The efficiency indices for the Experimental and Control Groups in the nursing aide segments are also different, though not so striking. These figures again represent the ratio of gain scores (for all course segments) to instructional hours (between Pre-test and Post-test I). (See Figure 6.) Though 24 hours of orientation instruction was similar for all groups, it would be unwise to subtract this figure from the calculation since the gain score was calculated on the basis of Pre- to Post-test change. On this basis, the efficiency index for the Control Group was .59, and those for Groups E_2 and E_1 were .84 and .88, respectively. Here is further support for the conclusion that Air Force materials would indeed be useful in improving civilian technical education.

The situation is not as clearcut as we have made it, of course. A number of variables intrude that might serve to reduce these differences under modified conditions. For example, one could maintain that the Utah instructors probably included in their traditional courses more instruction than is absolutely necessary for attaining the Air Force objectives and that they, too, could have done better with instruction that was oriented to the same criteria. Though this could be true, the situation is still noteworthy because of the differences in the ratios. If there is a moral here it is that the presence of specified objectives makes it possible to make decisions that improve the efficiency of instruction.

(An efficiency index for the aircraft mechanics portion of the study could not be computed due to the fact that course hours for both groups were the same, and that there were no significant differences between groups in gain scores).

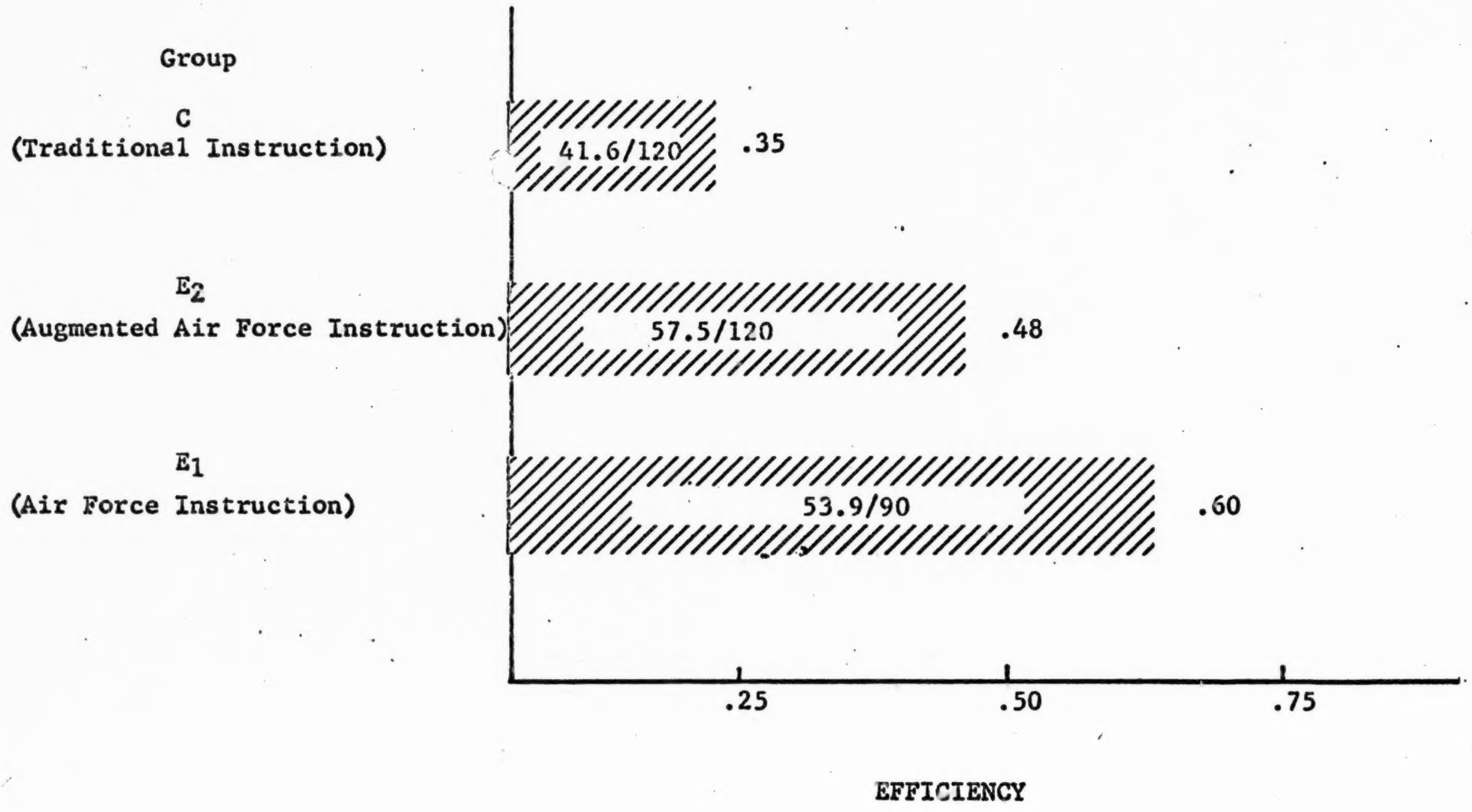

Figure 5. Efficiency Index (ratio of mean gain score to average completion time) for three groups receiving electronics instruction.

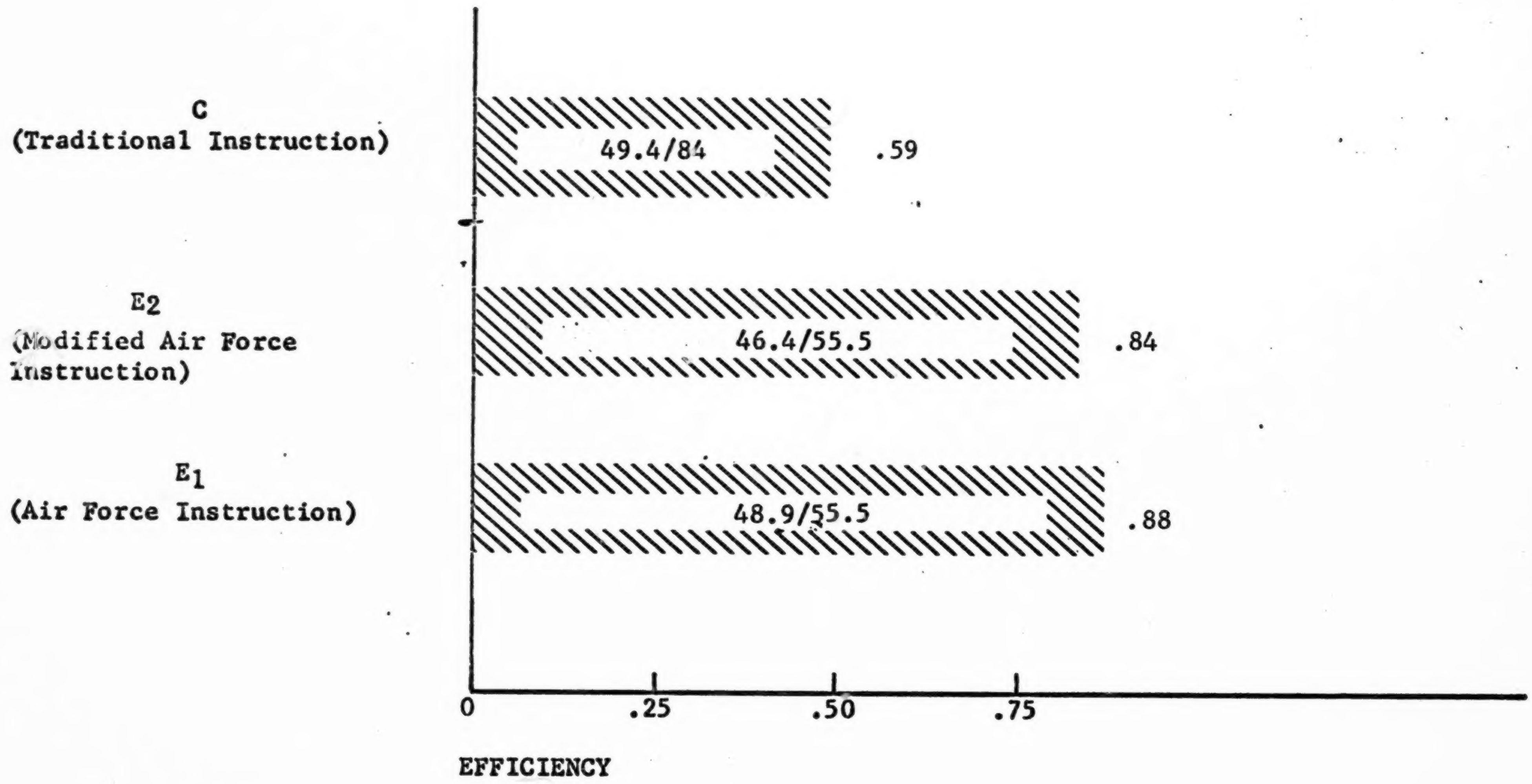

Figure 6. Efficiency Index (ratio of mean gain score to average completion time) for three groups of Nurse's Aide course.

To what extent might the results of the Utah study be applicable to other civilian schools?

Materials are applicable to the extent that the skills taught by them are in demand, and to the extent that they can be used by a relatively large number of institutions.

It has already been shown that the effectiveness of the materials tested is at least as satisfactory as those of the participating institutions, and for the electronics materials, at least, the performance gains were achieved by the instructors in considerably less time than typically consumed by the traditional courses. Thus, the materials were effective in Utah and there is no reason to believe that materials of other subject matter areas would not work in comparable fashion.

Further, there is little reason to think that most other vocational and technical schools are not similar to the Utah schools. Though it is certainly true that the cooperativeness and diligence of the instructors may be somewhat more pronounced than at other institutions, the instructional procedures followed by the Utah schools are similar to those of other schools.

Mention of instructor cooperation and diligence in the study suggests possible effects of novelty. It would be difficult to support as assertion that the effects of the Experimental Groups of this study were in any way due to a novelty effect, however. For one thing, both Experimental and Control Group instructors knew they were participating in an experiment. For another, it is likely that a relatively large and equal number of students in the various groups discovered the fact they were participating in an experiment. For a third, one of the instructors taught both Experimental and Control Groups (because of scheduling problems).

The big problem is one of determining appropriateness of a given Air Force course to a host institution. If selections are poorly made then it will certainly come to pass that the Air Force materials will not do the job expected of them, even though they do very well the job they were designed to do. Therefore, to insure that materials are appropriate it is highly desirable that institutions wishing to use them be expected to have their own objectives not only clearly "in mind," but also clearly on paper. Appropriateness can easily be determined by a comparison of the Air Force objectives with those of the host institution, and feasibility can be estimated by a review procedure similar to the one used by the Utah instructors.

Would Air Force courses affect attitudes of civilian students in a reasonably positive manner?

If the results reported here are any indication, the answer to this question must be given in the affirmative. Though the attitudes of the Experimental students do not reflect outright enthusiasm, they are similar to the attitude of the Control Group students. There were, it may be recalled, adverse reactions to the slides and the films of the electronics course. Nonetheless, attitudes seemed generally on the positive side of neutral.

It is difficult to determine the attitude-influencing characteristics of the instructional materials themselves, however, when instructors are so much a part of the course. It is well known that modeling influences of instructors are strong, and therefore it is likely that the instructors influenced attitude at least as much as did the materials.

There is no reason to believe, though, that the Air Force materials would not influence student attitude at least as favorably as do materials more generally in use.

Additional Results

Utah instructors in this project -- exposed to criterion-referenced courses, to the use of specified performance objectives, to a managerial rather than lecturing role -- were most cooperative in conducting the study, but some were skeptical and a few openly doubtful, at the outset, about the use of Air Force materials in the civilian classroom.

Instructor reaction at the completion of the project was extremely positive, to the extent that the instructors recommended that the Air Force course segments be integrated into the conventional course in each of the subject areas covered in the study. This reaction takes on added significance with the realization that several of these instructors personally had helped develop the conventional materials. Each considered it "my course." Yet, most favored its replacement with Air Force course materials.

A case in point is the registered nurse who taught the conventional Nurse's Aide course (her course) during the experiment and who was openly negative, at the start of the project, about the use of military materials and techniques. At the conclusion of the project, she volunteered to integrate the Air Force course segment into the Nurse's Aide curriculum at Utah Technical College in Salt Lake City. Her extra effort, done on her own time, made it possible to achieve this integration in the school semester immediately following the experimental period.

Several instructors who participated in the electronics portion of the study served as members of a committee which, at a 1969 summer workshop, developed a course guide on the AC/DC electronics package previously referred to in this report. This project, a direct outgrowth of the study, is the first major effort in Utah to articulate high school electronic courses with those offered at post-secondary institutions.

Preparation and publication of this guide, a compendium titled "Articulated Guide for Secondary and Post-Secondary Electronics," is noteworthy. One of the problems that came to light during the course of the study was the difficulty experienced by Utah instructors in making initial comparisons between Air Force objectives and their own objectives, since their own objectives were not written down nor understood to the same level of specificity as the Air Force objectives. This compendium of objectives for the AC and DC portions of the electronics course, published by the Utah State Department of Public Instruction, has been distributed to all electronics teachers in the state of Utah for their guidance. It is expected that they will review and suggest modification to the Guide, and then begin to modify their instruction so that it achieves stated objectives. In this manner it is expected that significant coordination between the electronics courses of the various institutions will be developed. And further, as the guide comments: "The committee has received assurance from the electronic technology department of post-secondary schools contacted that any entrance or qualifying examinations given in the future will be based entirely on the objectives in this guide."

The relationship of this effort to the Utah project covered in this report is indicated by this statement in the foreword to the Guide:

"Some members of the committee have been involved previously in a study to evaluate the desirability of using Air Force teaching materials in electricity/electronic classes in Utah. The evaluation indicated that the materials were generally very adaptive to civilian use. The AC and DC topics considered necessary by the Air Force are included in this guide. The military has films to cover every objective in their instructional plans. These films, as well as the software, will be made available to all users of this guide at a later date. Inasmuch as many high school graduates will go directly into the military service, the exposure to Air Force training materials may provide them with an educational advantage."

Follow-on action in Utah, resulting directly from this project, can be summed up as follows:

* Air Force techniques and course materials, in each subject area studied, have been integrated into the regular curriculum in five of the schools engaged in the project.

* The Air Force course segment in electronics (direct current) has been integrated into the regular curriculum at two additional high schools.

* The Air Force course segment in Nurse's Aide has been integrated into the regular curriculum at an additional technical college. This includes the use of Air Force programmed texts for each of the eight course units in this segment.

* Materials for an Air Force electronics course segment on alternating current have been obtained for integration into the regular curriculum of the test schools. This AC unit includes 28 hours of film converted from Air Force videotape at Utah state's expense.

* Air Force electronics course segments have been incorporated into an AC/DC package designed for state-wide use, including a TV adaptation for home study. This electronics package is the subject of a course guide, published by the Utah State Department of Public Instruction, and distributed state-wide for coordination purposes. The guide can be considered to be the first step in the movement toward an "articulated" electronics curriculum linking performance achievement levels at high schools and post-secondary schools.

* Industrial and union contributions to the new electronics learning package, initiated at a two-week workshop with Utah educators, can be considered to be the first step in making the Utah educational system more accountable to the largest employers in the state, and to the taxpayers and students of Utah as well.

* Utah authorities are developing a proposal for more Air Force medical material to develop a cluster of teaching packages enabling a student to progress from Nurse's Aide to Licensed Practical Nurse to a two-year associate degree in nursing, or move toward employment at any given point in the training cycle.

* At the request of Utah authorities, Air Force POI's (Plans of Instruction) are being evaluated for possible adaptation. Course subjects include computer operation, data processing machine operator, and automotive mechanics.

* Utah educators, on request, are studying information on additional Air Force course segments in basic electronics, as follows: solid state devices, vacuum tubes, oscilators, receiver principles, motors and servo-mechanisms, wave-shaping circuits, and micro-wave principles.

* Preliminary meetings have been held relating to possible adaptation of self-paced Air Force courses in basic electronics, with full consideration given the ramifications in breaking from conventional group teaching.

Meanwhile, in the state of Michigan, Air Force POI's (made available through the Aerospace Education Foundation) are being utilized in a potentially important study jointly sponsored by the U. S. Labor Department, Michigan Employment Security Commission, and the Michigan State Department of Education, with Battelle Memorial Institute as the research agency. Here an effort is being made to reduce the discrepancies between civilian job entry requirements and the skill levels of high school graduates. Based on Battelle's experience in the Utah project, Air Force Plans of Instruction being utilized in Michigan cover the following subject areas: dental specialist, medical helper, medical service specialist, electrician, machinist, ground radio communications equipment repairman.

XI. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

A number of tentative conclusions may be drawn from the data generated by the present study, even though circumstances forced some weaknesses in experimental design.

1. Use of Air Force techniques and materials resulted in student performance judged to be as good or better, in each instance, than did the use of conventional techniques and materials. Both electronics groups using Air Force materials performed significantly better than the group receiving regular instruction; the students using Air Force materials in aircraft mechanics performed slightly better than their Control Group; and the less educated students of the Nurse's Aide Experimental Group improved significantly in more subject areas than did their better educated colleagues in the Control Group.

2. Attitudes of students using Air Force materials was as favorable to their instruction as was the attitude of those receiving the instruction usually offered by the Utah schools.

3. For the courses investigated in this study, at least, little or no modification is required for use in civilian schools. It is clear, however, that for some courses equipment costs are so high as to limit or prohibit their use. Costs associated with the use of the three courses studied cannot be precisely computed in terms of future experience.

4. While Air Force materials can be used with good results by instructors with limited experience in teaching criterion-referenced courses, it is clear that improved effectiveness will result if instructors are in a position to make explicit comparison between their own instructional objectives and those of an Air Force course under consideration.

5. Since there is no reason to believe that the Utah schools are much different from other schools of similar mission, it is highly likely that Air Force materials can be used with at least the same effectiveness in a large number of schools other than those of Utah.

Recommendations

1. That military educational concepts, techniques, course materials and equipment requirements, on a broad scale, be inventoried and assessed in terms of their applicability and their dissemination to civilian education, with full cognizance of this experience in Utah.

2. That further study be made of Air Force techniques and course materials, based on this Utah project, to determine how more effective use of them might be made by civilian institutions.

3. That a specific study be made of the Air Force use of performance objectives, and of the ability of civilian educators to relate such objectives to their own requirements, with guidelines suggested for the effective application of such objectives to civilian vocational-technical education.

XII.

Appendix A

Materials for Electronics Course

The software (printed materials) used by the Experimental Groups included:

(1) Student Workbook - TVI Guide: ATC Standardized Electronic Principles (ETV) - Block I: DC Circuits,

(2) Student Workbook (Homework) AQR30020: ATC Standardized Electronic Principles (ETV) - Block I: DC Circuits,

(3) Student Workbook: Standardized Electronic Principles Course (ETV) - Block I: DC Circuits (AQR30020),

(4) Student Workbook: Comprehensive Study questions - Block I: DC Circuits,

(5) Student Study Guide: ATC Standardized Electronics Principles (ETV) - Block I: DC Circuits,

(6) Lowry Technical Training Center Student Reference Data Book: Electronic Data,

(7) 268 35mm Instructional Slides.

The prime instructional technique utilized in the Experimental Groups was a series of 37 films. The reference number, length, and title of each of these films are shown below.

(1) TV-104 (30 min.), Atomic Structure of Matter,

(2) TV-105 (18 min.), Conductors and Insulators,

(3) TV-106 (29 min.), Charged Bodies,

(4) TV-108A (34 min.), Current and EMF,

(5) TV-108B (19 min.), Resistance,

(6) TV-109A (20 min.), Construction of Resistors,

(7) TV-109B (33 min.), Color Code of Resistors,

(8) TV-1003 K (22 min.), Powers of Ten,

(9) TV-110A (32 min.), Basic Circuit Symbols and Components,

(10) TV-110B (23 min.), Basic Circuit Sympols and Components, (Battery Circuits),

(11) TV-112 (37 min.), Use of Ohmmeter,

(12) TV-113 (39 min.), Use of Ammeter,

(14) TV-1106K (23 min.), Simple Equations,

(15) TV-118 (20 min.), Ohm's Law,

(16) TV-119 (27 min.), Series DC Resistive Circuits,

(17) TV-121 (29 min.), Series Resistive Circuits (DC Power),

(18) TV-122 (35 min.), Series Resistive Circuits (Trouble-shooting),

(19) TV-123 (27 min.), Voltage Dividers,

(20) TV-123 (24 min.), Rheostats and Potentiometers,

(21) TV-126A (33 min.), Parallel Resistive Circuits,

(22) TV-126B (23 min.), Parallel Resistive Circuits (Circuit Analysis),

(23) TV-126C (33 min.), Parallel Resistive Circuits (Circuit Analysis),

(24) TV-128 (21 min.), Parallel Resistive Circuits (DC Power),

(25) TV-129 (25 min.), Parallel Resistive Circuits (Trouble-shooting),

(26) TV-131A (40 min.), Series - Parallel Resistive Circuits (Circuit Analysis),

(27) TV-132L (24 min.), Series - Parallel Resistive Circuits (Troubleshooting),

(28) TV-133 (32 min.), Loaded Voltage Dividers,

(29) TV-134A (30 min.), Resistive Bridge Circuits (Balanced),

(30) TV-134B (26 min.), Resistive Bridge Circuits (Unbalanced),

(31) TV-135A (34 min.), Magnetism,

(32) TV-135B (34 min.), Magnetism,

(33) TV-136 (25 min.), Electromagnetism,

(34) TV-137 (18 min.), Relays,

(35) TV-138 (25 min.), Vibrators,

(36) TV-1017AK (24 min.), Meter Movement Circuits,

(37) TV-1017BK (22 min.), Volt, Ohm, and Multimeter.

Appendix B

Materials for Aircraft Mechanics Course

The software (printed materials) utilized by the Experimental Group included three major items:

(1) Eleven instructional units from Block II and one instructional unit from Block III of ABR 4132--Aircraft Pneudraulic Repairman and workbook exercises.

(2) Five instructional units from Block II of ABR 42172--Aircraft Pneudraulic Repair Technician and their accompanying workbook exercises, and

(3) Segments from a 3 volume Air University Course 42152--Aircraft Pneudraulic Repairman/Technician.

The first item, twelve instructional units from ABR 42132--a Basic level course, included material covering the following topics:

Block II - Units

(1) Basic Pneudraulic Power Systems

(2) Hand Pumps, Reservoirs, and Filters

(3) Vickers Constant Volume Pump

(4) Stratopower and Kellogg Pumps

(5) Relief and Simple Flow Control Valves

(6) Accumulators, Pressure Regulators, and Switches

(7) Selector Valves

(8) Actuators

(9) Flow Control Valves

(10) Shock Struts

(11) Shimmy Dampers and Nose Wheel Steering Valves.

Block III - Systems

(1) Steering Systems

The second item, five instructional units from AAR 42172--an Advanced level course, included material covering the following topics:

(1) Operation, Maintenance and Repair of Power Pumps, and Hydraulic Motors

(2) Operation, Maintenance and Repair of Flow Control Valves

(3) Operation, Maintenance and Repair of Relief Valves

(4) Operation, Maintenance and Repair of Pressure Regulators

(5) Operation, Maintenance and Repair of Selector Valves and Actuation Cylinders.

The third item included the relevant segments from an Intermediate level course which is normally undertaken not on a military bases but in the field in conjunction with an OJT program. The selected material included the following content:

(1) Chapter 1 - Basic Hydraulic Systems

(2) Chapter 2 - Pneudraulic Power Systems

(3) Chapter 3 - Pneudraulic Actuating Systems

(4) Chapter 4 - Pneudraulic System Supply Units

(5) Chapter 5 - Pressure-Regulating, Limiting, and Controlling Devices

(6) Chapter 6 - Flow Control and Directional Units

(7) Chapter 7 - Landing Gear Components

(8) Chapter 8 - Use of Hydraulic Schematics

(9) Chapter 9 - Hydraulic Fluids and Plumbing Materials.

In addition to the instructional software prepared for civilian student use, a variety of instructional aids utilized by the Air Force instructors also were made available for use by the Experimental Group, including 74 slides.

In addition to the hardware normally utilized in this course the experimental treatment group had available for use equipment obtained through government surplus channels including:

(1) Vickers Constant Volume Pumps

(2) Vickers Variable Volume Pumps

(3) Stratopower Pumps

(4) Pressure Relief Valves

(5) Regulators

(6) Four-way Selector Valves

(7) Relief Valves.

Appendix C

Materials for Nurse's Aide Course

Following indicates the software utilized by the Experimental Groups. Materials are indicated for each of the segments of the course:

1. Sterile Equipment and Supplies (Air Force Course ABR 90230)

   Student Workbook
   Instructor Lesson Plan
   Five 35mm slides

2. Common Disease-Causing Organism (Air Force Course ABR 90230)

   Instructor Guide
   Programmed Text

3. Surgical Aseptic Technique (Air Force Course ABR 90230)

   Lesson Plan
   Student Study Guide (semi-programmed)
   Film TV 162 652 "Surgical Aseptic Technique"
   Five 35mm slides

4. Medical Aseptic Technique (Air Force Course ABR 90230)

   Instructor Guide
   Programmed Text

5. Medical Terminology (Air Force Course AQR 90010)

   Programmed Learning Unit

6. Comfort and Hygiene (Air Force Course ABR 90230)

   Instructor Guide
   Student Study Guide/Workbook (semi-programmed)

7. Diets (Air Force Course ABR 90230)

   Instructor Guide
   Student Study Guide (semi-programmed)

8. Lifting and Moving Patients (Air Force Course ABR 90230)

   Student Workbook
   Lesson Plan
   Five 35 mm slides

XIII. ABSTRACT

Research designed to determine empirically whether vocational-technical military experience can be transferred effectively into the civilian education system. Segments of three U. S. Air Force instructional systems selected by Utah educators. Tested in six Utah schools ranging from high school to four-year college.

Air Force segments utilized: Electronics Principles (90 hours); Aircraft Pneudraulics (pressure mechanics - 60 hours); and Nurse's Aide (20 hours). Segments generally offered in two forms (experimental); one as offered by Air Force; other with augmentations (i.e. additional algebra unit in electronics course); semi-random student selection; experimental student performance as good or better than control group student performance; gain scores generally favored experimental groups.

In Electronics and Nurse's Aide courses completed in substantially less class time than control courses. Little or no modification of Air Force materials. Feasibility of using Air Force course materials in Utah's classrooms supported by reaction of Utah educators. In subject areas studied and at request of Utah teachers, Air Force techniques and materials integrated into regular curriculum, and in other schools. Further, additional courses requested, and state-wide application of instruction based on specified performance objectives, as exemplified by Air Force courses, now in progress. Evidence points to the conclusion results generally are applicable to other states.